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E-Mail: James.Rome@ stelnews.info Phone: +1 (865) 482-5643
On the Web at https://stelnews.info

Wendelstein 7-X scientific campaign planning in full swing

In preparation for the upcoming Wendelstein 7-X (W7-X) operation campaigns OP 2.2 and OP 2.3, the scientific program is under development. During the proposal submission period in February 2024, 400 scientific proposals were submitted. With the proposals transferred from the previous operation campaign, about 700 proposals have been considered and prioritized, along the main scientific objectives of the operation campaigns, by the three scientific task forces. The resulting 35% of proposals with highest priority form the basis of the detailed planning of the campaign. The emerging program was discussed with the entire W7-X team and the international program committee in the framework of a program workshop, which took place for two days (24–25 April) at IPP Greifswald. These focused discussions identified aspects of some proposals that require further refinements. This process is currently ongoing. Start of plasma operation is envisaged for fall 2024.

Fig. 1. Number of prioritized proposals for the three scientific task forces.

In this issue . . .

On the effect of flux-surface shaping on trapped-electron modes in quasihelically symmetric stellarators

Optimizing three-dimensional (3D) stellarator magnetic fields for reduced turbulence is an active field of investigation. While tools exist to predict turbulent transport for selected stellarator configurations, these state-of-the-art simulation codes are computationally expensive, making embedding them in optimization routines challenging. Therefore, a detailed understanding of turbulence and the development of reduced models is necessary to design next-generation stellarator fusion experiments. To investigate the influence of flux-surface shaping on the trapped-electron mode (TEM) drift-wave instability, a large database of stellarator equilibria for the Helically Symmetric eXperiment (HSX) stellarator, a quasihelically symmetric device [1] has been scanned. This flux-surface geometry scan has been performed using the gyrokinetic code GENE, and flux-surface shapes are characterized by parameters such as elongation, triangularity, and squareness, adapted from the Tokamak case for non-axisymmetric geometries [2].

Gyrokinetic simulations show that the lowest TEM growth rates occur in configurations with relatively good quasi-helical symmetry, low available energy, and high plasma elongation. Importantly, the dependence of growth rates on quasihelical symmetry and available energy shows similar trends, though the trends are more clearly seen for quasisymmetry. In addition, the growth rate reduction with increasing elongation is not predicted by either quasisymmetry or available energy. This is demonstrated in Fig. 1, where TEM growth rates at four binormal wave numbers are shown as a function of the quasisymmetry of each configuration, with low values indicating good quasisymmetry, and plasma elongation shown in color. This suggests that when optimizing a quasihelically symmetric configuration for reduced TEM growth rates, optimizing for increased plasma elongation and either enhanced quasisymmetry or reduced available energy is beneficial.

When investigating the physics mechanism of the growth-rate reduction via increased elongation, it is found that increasing elongation leads to a reversal in the phase-space-averaged trapped-electron particle drifts from the electron- to the ion-diamagnetic direction. However, this reversal occurs in some, but not all, of the helically linked magnetic trapping wells, meaning the optimized configurations show no sign of becoming maximum-J type configurations as in the Wendelstein 7-X stellarator [3]. Regarding the quasihelical symmetry, it is shown that breaking the symmetry increases the wave-particle resonance of the maximally resonant trapping well. This increase is likely explained by the inclusion of symmetry-breaking trapping wells, which produce highly destabilizing trapped-electron drifts.

This work provides crucial insight into optimizing quasihelically symmetric stellarators for reduced TEM growth rates. Efforts continue to investigate the effect of reduced growth rates on nonlinear heat fluxes and to explore a few optimized configurations experimentally in HSX at the University of Wisconsin at Madison.

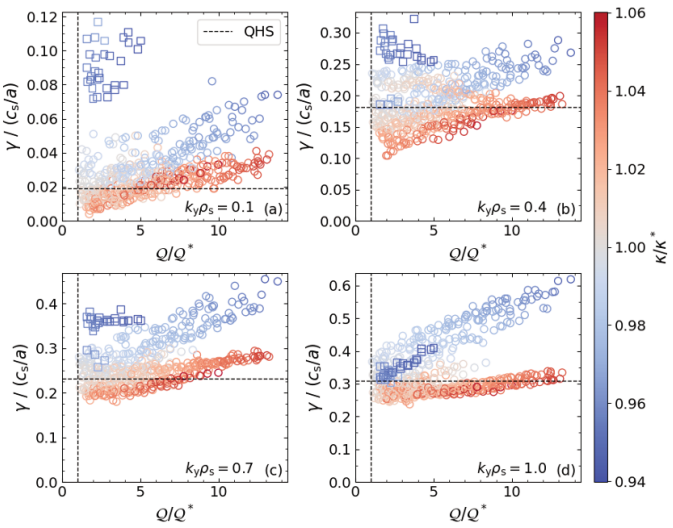

Fig. 1. Growth rates as a function of symmetry-breaking ratios at binormal wave numbers 0.1, 0.4, 0.7, and 1 in panels (a), (b), (c), and (d), respectively, with elongation ratios shown in color. The black cross-hairs indicate the quasihelically symmetric configuration in each panel.

References

[1] M.J. Gerard, M.J. Pueschel, B. Geiger, R.J.J. Mackenbach, J.M. Duff, B.J. Faber, C.C. Hegna, and P.W. Terry, *Phys. Plasmas* **31**, 052501 (2024).

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[3] J.H.E. Proll, P. Helander, J.W. Connor, and G.G. Plunk, *Phys. Rev. Lett.* **108**, 245002 (2012).

Michael J. Gerard mjgerard2@wisc.edu
and
Benedikt Geiger benedikt.geiger@wisc.edu
University of Wisconsin-Madison
Madison, Wisconsin, U.S.A.

Press Release: Governor Lee, Commissioner McWhorter AnnounceType One EnergyGroup, Inc. To Establish HQ and Expand R&D Operations toTennessee

- Type One Energy is the first funding recipient through Tennessee's Nuclear Energy Fund
- Company to invest $223 million in East Tennessee
- Project includes a headquarters relocation, expanded research and development operations

NASHVILLE, Tenn. –Tennessee Gov. Bill Lee, Department of Economic and Community Development (ECD) Commissioner Stuart C. McWhorter and Type One Energy Group, Inc. officials announced today the company will invest $223.5 million to establish its headquarters and expand operations in Tennessee.

Type One Energy will create a total of 330 new jobs by establishing its headquarters in the Greater Knoxville region and expanding fusion research and development (R&D) operations in Clinton.

In addition, Type One Energy intends to locate at the Tennessee Valley Authority's (TVA) Bull Run Fossil Plant in Clinton, Tennessee, for the company's stellarator fusion prototype machine, Infinity One. Construction will begin following completion of required environmental reviews, partnership agreements, permits and operating licenses.

Type One Energy is a leading stellarator fusion energy company and the first recipient of funding through the $50 million Nuclear Energy Fund, which was proposed by Gov. Bill Lee and approved by the Tennessee General Assembly in the 2023-2024 budget.

The Nuclear Energy Fund, established by Executive Order 101, was created to support Tennessee's nuclear development and manufacturing ecosystem by providing assistance to nuclear power-related businesses choosing to relocate or grow in the Volunteer State.

Since 2020, TNECD has supported nearly 50 economic development projects in the East Tennessee region,

resulting in approximately 8,600 job commitments and $2.3 billion in capital investment.

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“Our administration created the Nuclear Energy Fund in partnership with the Tennessee General Assembly to recruit companies like Type One Energy. Tennessee is ready to secure its place as the top state for energy independence, and we are proud to partner with Type One Energy to further that mission and bring hundreds of high-quality jobs and more reliable energy to Tennesseans.” – **Gov. Bill Lee**

“With assets like Oak Ridge National Lab, Tennessee is the quintessential location for companies like Type One Energy to grow and succeed. This project will not only strengthen Tennessee’s R&D footprint but also further develop our nuclear sector, which wouldn’t be possible without the forethought of Gov. Bill Lee and our Tennessee General Assembly to create the Nuclear Energy Fund.” **– TNECD Commissioner Stuart C. McWhorter**

“Type One Energy will build the world’s most advanced stellarator at TVA’s Bull Run Fossil Plant. This prototype, Infinity One, will not only confirm the design and operation of our subsequent Fusion Pilot Plant, but will also become an excellent platform for a potential long-term national fusion research facility. We are excited to expand our operations in Tennessee in partnership with TVA and ORNL. We are also grateful for the leadership of Gov. Lee and his vision, which led to the Nuclear Energy Fund’s valuable support for this project.” **– Christofer Mowry, CEO, Type One Energy**

“I am very excited that the site of the Bull Run Fossil Plant is so quickly being repurposed to tackle the future energy needs of Tennessee, and the nation. I’m grateful to Type One Energy, Gov. Lee, TNECD, the Tennessee General Assembly and TVA for choosing Anderson County for this project location as part of the larger effort for Tennessee to take the lead in the advancement of nuclear energy. Whether it’s keeping us warm, running a hospital or powering businesses, we rely on energy — and this further effort to develop safe, clean, reliable nuclear is an enormous win.” **– Anderson County Mayor Terry Frank**

"Congratulations to Type One Energy and all the partnerships that helped this important project locate in East Tennessee. This is a great example of a next-generation, high-impact project that will benefit from the technology and workforce assets of our community. The Knoxville Chamber stands ready to champion Type One Energy’s headquarters operations as the project evolves." **– Doug Lawyer, Vice President of Economic Development, Knoxville Chamber**

“TVA is working with our partners to pursue new ideas and innovative solutions that meet growing energy demand in real-world conditions. We appreciate this partnership between Type One Energy, ORNL, our local power companies and elected and economic development officials as we work together to identify energy technologies for the future.” **– TVA President and CEO Jeff Lyash**

“The road to true energy independence for our nation is paved with nuclear energy. I am proud and grateful that Type One Energy has chosen Anderson County for this facility. Our region has become a unique and important hub for technological innovation. Type One Energy is exactly the kind of company that can move our region and our state forward, both economically and technologically. I look forward to Type One Energy and our area growing together bringing jobs and innovation to the region. I would like to thank Gov. Lee, Commissioner McWhorter, the General Assembly and the Tennessee Nuclear Energy Advisory Council for all they have done to make this possible.” **– Lt. Gov. Randy McNally (R-Oak Ridge)**

“I am proud to welcome Type One Energy to Clinton. Nuclear energy is not only incredibly important to Tennessee’s past, but its future as well. This project represents a substantial investment in our community that will bring new innovation and hundreds of new jobs to Anderson County. I was proud to support the creation of the Nuclear Energy Fund and the positive results it will have for this growing sector of our economy.” **– Rep. John Ragan (R-Oak Ridge)**