

Gwanggeun Seo

Department of Nuclear Engineering, Seoul National University
tjrhkdrms@snu.ac.kr

RESEARCH INTERESTS

I work on three-dimensional magnetic fields as an actuator in tokamaks: how the plasma responds to small non-axisymmetric fields, and how to choose those fields to control instabilities. My interests are 1) control of instabilities and disruptions with 3D magnetic fields, including error field correction and RMP optimization, 2) data-driven and physics-guided models for real-time plasma control, 3) 3D MHD equilibrium, stability, and plasma response to non-axisymmetric fields, and 4) optimization of 3D coil systems under engineering constraints, including stellarator–tokamak hybrid configurations. My approach spans simulation (GPEC/DCON plasma-response modeling, EFIT/FOCUS equilibrium and coil-design tools) through hands-on experiment (KSTAR error-field sessions, VEST coil hardware design and installation).

EDUCATION

Seoul National University <i>M.S. Candidate, Nuclear Engineering (Fusion Plasma)</i>	Seoul, Korea <i>Mar. 2025 – Feb. 2027 (expected)</i>
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- Advisor: Prof. Jong-Kyu Park
- Research focus: 3D MHD physics, error-field correction, and coil optimization
- Supported by the BK21 FOUR graduate fellowship, Ministry of Education (Mar. 2025 – Present)
- M.S. thesis in preparation
- Coursework: Theory of Fusion Plasmas I; Graduate Quantum Mechanics I; Social Dimension of Nuclear Energy

Seoul National University <i>B.S., Nuclear Engineering</i>	Seoul, Korea <i>Mar. 2019 – Feb. 2025</i>
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- Completed in eight semesters; undergraduate thesis: “Initial 3D Coil Design and Optimization in VEST”
- Mandatory military service, Republic of Korea Army, Mar. 2021 – Sep. 2022
- Coursework: Introduction to Nuclear Fusion; Introduction to Plasma Physics; Plasma Electrodynamics I–II; Fusion Plasma Experiments; Numerical Analysis; Machine Learning and Deep Learning for Data Science (graduate course)

HONORS AND AWARDS

Poster Prize, 10th Asia-Pacific Conference on Plasma Physics (AAPPS-DPP 2026) [C2]	Oct. 2026
Best Paper Award for Undergraduate Research, Seoul National University	Feb. 2025

PUBLICATIONS AND MANUSCRIPTS

First-authored

- [P1] **G. Seo**, S. Han, J. Kim, Y. Lee, S. Yang, J.-W. Juhn, and J.-K. Park, “Revised error field assessment in KSTAR with profile diagnostics of resonant field penetration,” *Nuclear Fusion* **66**, 126043 (2026), doi:10.1088/1741-4326/aeac69. [first author]
- [P2] **G. Seo**, J.-K. Park, S. J. Han, and M. Dubrov, “Quasi-symmetric error field correction and applications to ITER,” arXiv:2609.29849 (2026) — to be submitted to *Nuclear Fusion*. [first author]

Co-authored

- [P3] G. Yu, X. Nie, **G. Seo**, D. Huang, H. Liu, J. Liu, J. Cho, H.-S. Kim, J. Xie, G. Zhuang, F. Ding, J.-K. Park, and C. Zhu, “A programmable stellarator-tokamak hybrid for million-scale magnetic-configuration discovery,” arXiv:2605.03599 (2026) — submitted to *Proceedings of the National Academy of Sciences*. [third author]
- [P4] H.-S. Yun, S. Lee, L. Jung, J.-M. Lee, G. Nam, **G. Seo**, et al., “Developing an IMAS-compatible platform for the university-scale tokamak VEST and its application to operating characteristics analysis,” *Plasma Physics and Controlled Fusion* **67**, 115021 (2025) — published. [co-author]
- [P5] E. M. Bursch, A. Xie, J. L. Barr, S. K. Kim, N. C. Logan, S. M. Yang, J. G. Bak, W. Choi, Q. Hu, J. W.

Juhn, J. Kim, J. Lee, N. Leuthold, J.-K. Park, C. Paz-Soldan, L. Piron, **G. Seo**, and J. Seo, “Demonstration of H-mode error field identification in a single discharge via island healing,” arXiv:2609.30452 (2026) — submitted to *Nuclear Fusion*. [co-author]

CONFERENCE PRESENTATIONS AND ABSTRACTS

- [C1] **G. Seo** et al., “Revised Intrinsic Error Field Assessment in KSTAR from Local Penetration Diagnostics,” **68th Annual Meeting of the APS Division of Plasma Physics**, Chicago, Illinois, Nov. 2–6, 2026. [oral, first author]
- [C2] **G. Seo** et al., “Intrinsic Error Field Diagnosis in KSTAR via Cross-Geometry Compass Scans and Rotating-RMP Validation,” **10th Asia-Pacific Conference on Plasma Physics (AAPS-DPP 2026)**, Busan, Korea, Oct. 11–16, 2026. [oral and poster, first author; **AAPS-DPP Poster Prize**]
- [C3] **G. Seo** et al., “Torque-aware error field correction for ITER using quasi-symmetric magnetic perturbations,” **52nd European Physical Society Conference on Plasma Physics**, Edinburgh, United Kingdom, Jun. 29 – Jul. 3, 2026. [poster, first author]
- [C4] J.-K. Park, **G. Seo**, et al., “Quasisymmetric correction to non-resonant error fields in ITER,” **67th Annual Meeting of the APS Division of Plasma Physics**, Long Beach, California, Nov. 17–21, 2025. [oral, second author]
- [C5] J.-K. Park, **G. Seo**, et al., “Quasi-symmetric optimization of 3D magnetic perturbations,” 29th Workshop on MHD Stability Control, Princeton, New Jersey, Jul. 23–25, 2025. [oral, second author]
- [C6] **G. Seo** et al., “Validation of QSMP-RMP Transition and Prospective QSMP Studies on VEST,” **4th International Fusion and Plasma Conference (iFPC 2025)**, Daejeon Convention Center, Daejeon, Korea, Jun. 9–13, 2025. [poster, first author]
- [C7] **G. Seo** et al., “Initial 3D coil design and optimization in VEST,” **3rd International Fusion and Plasma Conference (iFPC 2024)**, Seoul, Korea, Jun. 24–28, 2024. [oral, first author]

OTHER CO-AUTHORED CONTRIBUTIONS

- [O1] J.-K. Park, G. Shin, S. Kim, R. Shousha, S. M. Yang, N. C. Logan, Q. Hu, M. Kim, S. Han, S. Jo, **G. Seo**, et al., “Long-Pulse Sustainment of Edge Localized Mode Suppression via Integrated Resonant Magnetic Perturbation Control in KSTAR,” submitted to *Nuclear Fusion* (2026). [co-author]
- [O2] S. Han, **G. Seo**, et al., “Robustness and Effects of Quasi-Symmetric Magnetic Perturbation in KSTAR,” **10th Asia-Pacific Conference on Plasma Physics (AAPS-DPP 2026)**, Busan, Korea, Oct. 11–16, 2026. [co-author]
- [O3] S. Han, **G. Seo**, et al., “Quasi-Symmetric Magnetic Perturbation for Robust Tokamak Operation,” **67th Annual Meeting of the APS Division of Plasma Physics**, Long Beach, California, Nov. 17–21, 2025. [poster, co-author]

RESEARCH EXPERIENCE

Collaboration with Prof. Caoxiang Zhu’s Group, USTC **Jul.–Aug. 2024; Jul. 2025**

- Conducted joint research on a programmable stellarator–tokamak hybrid using saddle and dipole coils for large-scale magnetic-configuration discovery, contributing tokamak-relevant 3D perturbation analysis and introducing GPEC workflows.
- Contributed as third author to the resulting preprint. [P3]

Researcher, 3DST Lab, Seoul National University **Jun. 2023 – Present**

Undergraduate Researcher: Jun. 2023 – Feb. 2025; Graduate Researcher: Mar. 2025 – Present

VEST 3D Coil Optimization and Installation **2023 – 2025**

- Designed, screened, and optimized 3D coil systems for the VEST spherical tokamak with GPEC, EFIT, CHEASE, and FOCUS.
- Led the engineering design and integration of the power, wiring, and switching systems, building an in-house

switching system in place of a commercial unit quoted at approximately KRW 10 million (about USD 7,000) with improved rise-time performance. [P4], [C6], [C7]

ITER Error-Field Quasi-Symmetric Correction

2024 – 2026

- Applied the group’s quasi-symmetric magnetic perturbation (QSMP) concept to ITER as a torque-aware correction framework that also accounts for non-resonant components, and compared it against overlap- and resonance-based schemes.
- Demonstrated transfer of a correction optimized at 7.5 MA to the 15 MA baseline scenario below the modeled locking-risk threshold, and evaluated robustness against PF, TF, and CS coil-misalignment error fields.
- Conducted the work with the ITER Organization. [P2], [C3], [C4], [C5]

CPD Error-Field Correction / RMP Coil Optimization

2025 – Present

- Quantified PF/CS coil-misalignment error-field risk for CPD (Compact Pilot Device, a next-step fusion device being designed in Korea) via 24 single-coil GPEC response calculations and a 30,000-sample Monte Carlo scan, finding a 3.77% exceedance rate above the 8.2 G engineering reference.
- Evaluated three-row EFC coil geometries across poloidal span and vessel-offset variations to identify a minimum-current, clearance-qualified configuration, and showed that correcting all four rational surfaces to 0.82 G (117.1 kA) versus a core-only target (18.9 kA) is limited by the three-row design’s actuator rank.

KSTAR Error-Field Experiment

2024 – Present

- Submitted a KSTAR experimental proposal for a dedicated error-field experiment; the sessions were run with the KSTAR team at KFE, and I served as session leader for the 3D field sessions.
- Diagnosed a substantially increased intrinsic error field relative to the 2015 benchmark, introducing MID-OFFMID and rotating RMP cross-validation and separating locking from field penetration using ECE temperature fluctuations and CES rotation data.
- Led the first-author *Nuclear Fusion* paper, in collaboration with KFE, PPPL, and Columbia University. [P1], [C1], [C2]

Physics-Guided Surrogate Modeling toward Real-Time KSTAR RMP Optimization

2026 – Present

- Built a fault-tolerant, restartable HPC workflow for automated EFIT–DCON–GPEC processing and curated 17,734 validated KSTAR equilibria with shot-separated data splits.
- Trained a surrogate for the complex GPEC C_{coil} response operator; rational-surface-aware equilibrium features cut the median held-out error by nearly a factor of four, from 39.2% to 10.7%.
- Developed SVD-based n -RMP and constrained E -RMP optimizers under the 5 kA IVCC coil-current limit, reaching ~ 40 ms inference per equilibrium toward prospective real-time RMP optimization studies.

Research Student, SNU–PPPL Summer Collaboration

Jul.–Aug. 2025

Two months on site at Princeton Plasma Physics Laboratory, Princeton, NJ, and Columbia University, New York, NY

- Took part in the GPEC Hackathon at Columbia University (Aug. 2025), contributing 3D MHD stability and perturbed-equilibrium implementation.
- Consulted with the HBT-EP group at Columbia on non-axisymmetric coil design and incorporated their input into the ongoing VEST 3D coil update.
- Discussed the non-resonant treatment and torque-matrix formulation of the ITER quasi-symmetric correction at the 29th Workshop on MHD Stability Control [C5].

Additional Collaborations

- **Columbia** (Dr. Nikolas Logan, Evan Bursch): ongoing collaboration on KSTAR error-field physics, including 3D field inputs for KSTAR plasma control system work. **PPPL**: GPEC deployment on the institutional cluster. **Aditya-U**: GPEC advisory support.

TECHNICAL SKILLS

Plasma modeling:	GPEC, EFIT, KineticEFIT, DCON, CHEASE, FOCUS, OMFIT
Hardware:	Coil/power-system design, switching-circuit design and installation, ECE/CES diagnostic analysis
Programming and ML:	Python, Fortran, C/C++, MATLAB, Julia, PyTorch, scikit-learn, NumPy/SciPy
Computing:	Linux, HPC cluster workflows, parallel CPU computing, MDS+, Git, $\text{\LaTeX}$
Languages:	Korean (native), English (fluent; TOEFL iBT 100), Korean Sign Language (intermediate), Chinese (basic)

LEADERSHIP, SERVICE, AND ACTIVITIES

- **KFAS Study Abroad Program**, Korea Foundation for Advanced Studies (2026 – Present).
- **CBRN Smoke Equipment Instructor**, Republic of Korea Army (Mar. 2021 – Sep. 2022): technical instruction to groups of 30–100 personnel per session, from enlisted soldiers to officers and civilian firefighters.
- **Laboratory Leader** (2024) and **Deputy Laboratory Leader** (Jan. 2026 – Present), 3DST Lab, Seoul National University.
- **Education Volunteer**, Samsung Sori-Saem Welfare Center (2025 – Present); long-term disability-services volunteer.
- **Member, Hanam Dreamers**, Hanam City university-student leadership group (2020).