Zhi-De Deng, Ph.D.

Neuroengineer | Stimulation Devices, Neural Sensing, and First-in-Human Translation

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SUMMARY

Neuroengineer who builds stimulation devices and has taken a first-in-human trial through FDA review. Developed MIST, a 15-channel stimulator for multi-electrode, individualized electroconvulsive therapy (ECT), with real-time impedance monitoring and automatic enforcement of FDA energy limits. Prepared the approved Investigational Device Exemption (IDE) for iLAST, a first-in-human trial of individualized low-amplitude ECT; led its FDA Pre-Submission meetings; and served as lead investigator. Built patient-specific electric-field models that set dose and targeting for NIH- and DoD-funded trials. Founded and directed the Computational Neurostimulation Research Program at the National Institute of Mental Health. Inventor on 4 granted U.S. patents and 3 pending international applications on brain stimulation technology.

TECHNICAL SKILLS

- **Electric-field modeling:** FEM; BEM-FMM; GPU real-time solvers; adaptive mesh refinement; MRI-to-mesh pipelines; multi-electrode montage optimization.
- **Neural response modeling:** NEURON; myelinated-axon and sensory fiber models; neuron activation thresholds; excitatory/inhibitory population, Epileptor seizure, and spreading-depolarization models.
- **Stimulator hardware:** Isolated multichannel current sources; FPGA and embedded control (NI myRIO); safety interlocks and real-time monitoring; TMS coil design; stimulation safety near implanted leads.
- **Neuroimaging and recording:** EEG, MEG, fMRI, DTI; combined TMS–fMRI, closed-loop TMS–EEG.
- **Software:** Python, MATLAB, R, C/C++; GPU and high-performance computing.
- **Regulatory and translation:** FDA Q-Sub and IDE submission; bench and electrical safety testing; device risk analysis; first-in-human and randomized trials; 10 IP filings.

PROFESSIONAL EXPERIENCE

National Institute of Mental Health (NIMH), National Institutes of Health, Bethesda, MD | 2016 – 2026

Senior Associate Scientist (Research Professor equivalent), 2025 – 2026
Director, Computational Neurostimulation Research Program, 2019 – 2026
Staff Scientist (2019 – 2025); Research Fellow (2016 – 2019)

- Founded and directed the Computational Neurostimulation Research Program: built patient-specific electric-field models that set targeting and dose for NIH- and DoD-funded trials, and mentored postdoctoral and graduate fellows.
- Prepared the IDE submission for iLAST (individualized low amplitude seizure therapy), a first-in-human trial of individualized, lower-amplitude ECT; led the Pre-Submission (Q-Sub) meetings with the FDA; served as lead associate investigator. The IDE was approved.
- Led development of MIST, a 15-channel, FPGA-controlled ECT stimulator with battery-isolated current sources (up to 900 mA, 120 Hz). Pulse-by-pulse monitoring forecasts delivered energy and aborts any train that would exceed FDA limits. Lead inventor on two PCT applications (WO 2024/215761, WO 2025/254758).
- First author of a randomized controlled trial of magnetic seizure therapy versus ECT (*JAMA Psychiatry*, 2024).
- Co-authored a 396-neuron analysis from electron microscopy: microscopic field perturbations shifted thresholds by under 10% (*Brain Stimulation*, 2025).
- Principal investigator (PI) of a NARSAD Young Investigator Award (2018 – 2020) to develop individualized, computationally directed multi-electrode seizure therapy.

Duke University School of Medicine, Psychiatry and Behavioral Sciences, Durham, NC | 2010 – 2020

Adjunct Assistant Professor (2016 – 2020); Medical Instructor (2014 – 2015); Postdoctoral Associate (2013 – 2014); Visiting Graduate Research Assistant (2010 – 2013)

- Developed the transcranial magnetic stimulation (TMS) coil that enabled simultaneous TMS and single-neuron recording in alert nonhuman primates (*Nature Neuroscience*, 2014).
- Mentored PI of an NIH/NCATS KL2 Career Development Award and PI of a Duke pilot grant on individualized, optimally targeted, low-amplitude seizure therapy.
- Co-investigator on an industry-sponsored low-field magnetic stimulation coil design (Tal Medical) and a Janssen-sponsored study of evoked-potential markers of cortical plasticity.

Columbia University, Department of Psychiatry, New York, NY | 2007 – 2010
Graduate Research Assistant (Ph.D. research, Electrical Engineering)

- Quantified currents induced in implanted deep brain stimulation leads during TMS and ECT (IEEE EMBC 2010; technical report for St. Jude Medical/Advanced Neuromodulation Systems).
- Modeled 50 TMS coil designs and characterized the depth–focality tradeoff (*Brain Stimulation*, 2013; Highly Cited Research).
- Co-invented magnetic stimulation systems (U.S. Patents 8,801,589 and 9,295,853) and a coil with electronically switchable active and sham modes (U.S. provisional application).

Harvard–MIT Division of Health Sciences and Technology, Cambridge, MA | 2005 – 2007
Research Assistant

- Developed Bayesian estimation algorithms for chaos in heart-rate variability, yielding a noninvasive marker of pediatric obstructive sleep apnea (U.S. Patent 9,737,258).

Industry Advisory | 2017 – present

- Consultant, NeuroSynchrony Health (2024 – present).
- Co-founder & Scientific Advisor, Singula Institute (2017 – 2025).

EDUCATION

Ph.D., Electrical Engineering, Columbia University, 2013
M.Phil., Electrical Engineering, Columbia University (graduate concentration in Neuroscience), 2011
M.Eng., Electrical Engineering and Computer Science, Massachusetts Institute of Technology, 2007
S.B., Electrical Science and Engineering, Massachusetts Institute of Technology, 2007
S.B., Physics (minor in Economics), Massachusetts Institute of Technology, 2006

PATENTS

- **Pending international (PCT) applications:** multichannel individualized stimulation therapy, WO 2024/215761 (U.S. and EP national stages pending; lead inventor; NIH); adjustable-current individualized stimulation therapy, WO 2025/254758 (lead inventor; NIH); electroconvulsive therapy, WO 2024/148196 (U.S. national stage pending; University of New Mexico).
- **Granted U.S. patents:** magnetic stimulation methods, apparatus, and systems, 8,801,589 and 9,295,853 (Columbia University); whole-body non-contact electrical stimulation device, 10,551,449 (NEVA Electromagnetics); detecting physiological abnormality using cardiac chaos, 9,737,258 (MIT).
- **U.S. provisional applications (3):** neuromodulation device and system; seizure titration and electric-field modeling in ECT; TMS coil with switchable active and sham modes.

SELECTED PUBLICATIONS

114 peer-reviewed publications, including 74 original research articles; full list at www.zzzdeng.net.

- **Deng ZD**, Luber B, McClintock SM, et al. Clinical outcomes of magnetic seizure therapy vs electroconvulsive therapy for major depressive episode: A randomized clinical trial. *JAMA Psychiatry* 2024;81:240–249.
- **Deng ZD**, Lisanby SH, Peterchev AV. Transcranial magnetic stimulation in the presence of deep brain stimulation implants: Induced electrode currents. *Proc. IEEE EMBC* 2010:6821–6824.
- Mueller JK, …, **Deng ZD**, Peterchev AV, …, Grill WM. Simultaneous transcranial magnetic stimulation and single-neuron recording in alert non-human primates. *Nat. Neurosci.* 2014;17:1130–1136.
- **Deng ZD**, Lisanby SH, Peterchev AV. Electric field depth–focality tradeoff in transcranial magnetic stimulation: Simulation comparison of 50 coil designs. *Brain Stimul.* 2013;6:1–13.
- Qi Z, …, **Deng ZD**, Nummenmaa AR, Makaroff SN. Enabling electric field model of microscopically realistic brain. *Brain Stimul.* 2025;18:77–93.
- Hasan NI, Dannhauer M, Wang D, **Deng ZD**, Gomez LJ. Real-time computation of brain E-field for enhanced TMS neuronavigation and optimization. *Imaging Neurosci.* 2025;3.

PROFESSIONAL LEADERSHIP AND AWARDS

- Technical Reviewer, NIH Blueprint MedTech Program (2021 – 2025); Expert Reviewer, UK Research and Innovation (2025); NIH Biophysics of Neural Systems Study Section (2021); IEEE Senior Member (Engineering in Medicine and Biology Society).
- NIMH Director's Award (2024) for outstanding transdisciplinary contributions to advancing neuromodulation technology; NIMH Director's Award (2019) for innovation at the interface of computation and psychiatry.
- Editorial Board, *Brain Stimulation*; Deputy Editor, *Transcranial Magnetic Stimulation*; Associate Editor, *Frontiers in Psychiatry*; Guest Editor, *Physics in Medicine and Biology* special issue on electromagnetic modeling for brain stimulation (2024).