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Education

Princeton University

PhD in Astrophysical Sciences, Program in Plasma Physics 2016
Measurements of impurity concentrations and transport in the Lithium Tokamak Experiment

MA in Astrophysical Sciences, Program in Plasma Physics 2010

Columbia University School of Engineering and Applied Science

BS in Applied Physics, *magna cum laude* 2008

Research

Lithium Tokamak Experiment- β – Staff Research Physicist 2019 - Present
Associate Research Physicist 2016 - 2019

Supervisor: R Majeski Princeton Plasma Physics Laboratory

Confinement studies of low-recycling plasmas with expanded operational parameters

- Led or supported majority of activities to complete upgrade and DOE notable outcomes
 - Closely involved with nearly every subsystem of the experiment
 - Designed, improved, coordinated, implemented, maintained, operated, and/or analyzed majority of machine, diagnostic, and experimental systems
- Upgraded, recommissioned, calibrated, operated, maintained, wrote software for, and analyzed data from Thomson scattering system
 - Completed camera, spectrometer, viewing optics, and laser upgrades
 - In-vacuum laser realignment, improved timing and background rejection
 - Labsphere, spectral, spatial, laser energy, and Rayleigh scattering calibrations
 - Collaborated with beam dump upgrade and high-field side Thomson design
- Thomson scattering data and TRANSP confinement analysis for notable reports, paper
- Led plasma operations, vacuum conditioning, pump down, and numerous preparations
 - Exceeded LTX machine and plasma performance, with and without lithium
 - Extended low-recycling regime to liquid Li, higher current, and longer duration
 - Developed and optimized discharges for NBI testing, beam fueling study, lithium operations, wall retention measurements, high field, and high current operation
 - Testing and monitoring of coils, shells, power supplies, capacitor banks, etc.
- Improved plasma startup capabilities with shot programming, ECRH port, and filament
- Collaborated with CHERS and NBI design, installation, alignment, calibrations, software
 - Supported TRANSP/NUBEAM simulations, enabled storage/analysis of NBI data
- Worked to accomplish project's scientific mission and team members' individual goals
 - Supported colleagues and collaborators with equipment, data, planning, analysis
 - Co-authored papers, presentations, and invited talks
 - Provided coordination, training, expertise, and help to colleagues, collaborators
 - Wrote, revised, taught, learned, and safely executed PPPL procedures
 - Assisted COVID shutdown resiliency plan including remote monitoring

Lithium Tokamak Experiment – Doctoral Candidate

2011 – 2016

Advisor: R Kaita

Princeton Plasma Physics Laboratory

Experimental study of the effects of lithium-coated walls on transport in a tokamak using doppler, survey, and Thomson scattering spectroscopy

- First observation of flat temperature profiles with hot edge in low-recycling regime
 - TRANSP analysis showed greatly improved electron energy confinement
- First ever successful operation of a tokamak fully surrounded by liquid lithium
- Operated and optimized tokamak; installed, maintained, and operated subsystems
 - Vacuum, electrical, high pressure gas/liquid, cryogenic, lithium, diagnostics, data
 - Installed, calibrated, automated, & operated multiple visible/EUV spectrometers
 - Designed and implemented upgrade to visible spectroscopy collection optics
- Re-aligned, re-calibrated, and improved Thomson scattering system
- Results showed low to modest core impurity levels with solid and liquid lithium coatings
 - Analysis in IDL and Python; TRANSP, NCLASS, and MIST for transport analysis

National Spherical Torus Experiment – Graduate Student Researcher

2010 – 2012

Advisor: R Maingi

Princeton Plasma Physics Laboratory

Investigation of the relationships between suppression of edge instabilities, evolution of edge plasma profiles, and lithium wall coatings using profile and edge stability analysis tools

- Analyzed NSTX datasets with GA pyTools, kinetic EFITs, IDL, MDSplus, and PEST
 - Fit ELM synced TS and CHERS pedestal profiles for analysis and input to ELITE
 - Assisted senior scientists, postdocs, students with learning, optimizing pyTools
- Yielded better understanding of how lithium suppresses instabilities

Levitated Dipole Experiment – DOE FES Graduate Fellow

2009

Advisor: ME Mauel

MIT Plasma Science and Fusion Center

Analysis of vessel eddy currents using a “Copper Plasma” to improve magnetic diagnostics

- Designed, constructed, and operated in-vessel copper coils to simulate plasma
- Analyzed magnetic data in IDL and Mathematica, improved calibration of sensors

Lithium Tokamak Experiment – Graduate Student Researcher

2008

Advisors: R Kaita and R Majeski

Princeton Plasma Physics Laboratory

Assembly of tokamak and installation of magnetic and spectroscopic diagnostics

Electrostatic Dust Detector – National Undergraduate Fellow

2007

Advisor: CH Skinner

Princeton Plasma Physics Laboratory

Optimization and characterization of electrostatic dust detectors for use in NSTX

Columbia Non-Neutral Torus – Undergraduate Research Assistant

2005 – 2008

Advisor: TS Pedersen

Columbia University

Design, machining, construction, and calibration of circuitry, probes, et cetera for diagnostics

Publications (first-author)

- [1] DP Boyle et al *Extending the low-recycling regime to higher performance discharges and liquid lithium walls in the Lithium Tokamak Experiment- β* **47th EPS Plasma Physics Conference** (2021) P1.1023
- [2] DP Boyle et al *Observation of flat electron temperature profiles in the Lithium Tokamak Experiment* **Physical Review Letters** 119 (2017) 015001
- [3] DP Boyle et al *Varying the pre-discharge lithium wall coatings to alter the characteristics of the ELM-free H-mode pedestal in NSTX* **Journal of Nuclear Materials** 438 (2013) S979–S982
- [4] DP Boyle et al *The relationships between edge localized modes suppression, pedestal profiles and lithium wall coatings in NSTX* **Plasma Physics & Controlled Fusion** 53 (2011) 105011
- [5] DP Boyle et al *Electrostatic dust detector for fusion devices with improved sensitivity* **Journal of Nuclear Materials** 390–391 (2009) 1086–1089

Publications and Reports (co-author)

- [6] W Capecchi et al *Neutral beam prompt loss in LTX- β* (to be submitted)
- [7] R Majeski and the LTX- β Group *LTX- β FY2021 Notable Outcome Report* **DOE FES** (2021)
- [8] A Maan et al *Oxidation of lithium plasma facing components and its effect on plasma performance in the Lithium Tokamak Experiment- β* **Plasma Physics and Controlled Fusion** 63 (2021) 025007
- [9] PE Hughes et al *Toroidal plasma acceleration due to NBI fast ion losses in LTX- β* **Plasma Physics and Controlled Fusion** (2021) online
- [10] R Majeski and the LTX- β Group *LTX- β FY2020 Notable Outcome Report* **DOE FES** (2020)
- [11] DB Elliott et al *Initial results from the newly upgraded LTX- β* **IEEE Transactions on Plasma Science** 48 (2020) 1382-1387
- [12] A Maan et al *Plasma facing component characterization and correlation with scrape-off layer conditions in low-recycling Lithium Tokamak Experiment- β plasmas* **IEEE Transactions on Plasma Science** 48 (2020) 1463-1467
- [13] A Maan et al *A simple vacuum suitcase for plasma facing component characterization in fusion devices* **Review of Scientific Instruments** 91 (2020) 026104
- [14] R Majeski and the LTX- β Group *The initial operation of LTX- β (Notable)* **DOE FES** (2019)
- [15] R Majeski et al *The LTX- β Research Program and First Results* **27th IAEA Fusion Energy Conference** (2018) EX/P8-29
- [16] DB Elliott et al *The charge exchange recombination spectroscopy diagnostic on the upgraded Lithium Tokamak Experiment (LTX- β)* **Review of Scientific Instruments** 89 (2018) 10D118

- [17] R Majeski et al *Compatibility of lithium plasma-facing surfaces with high edge temperatures in the Lithium Tokamak Experiment* **Physics of Plasmas** 24 (2017) 056110
- [18] C Hansen, DP Boyle, JC Schmitt, & R Majeski *Equilibrium reconstruction with 3D eddy currents in the Lithium Tokamak eXperiment* **Physics of Plasmas** 24 (2017) 042513
- [19] R Kaita et al *Hydrogen retention in lithium on metallic walls from “in vacuo” analysis in LTX and implications for high-Z plasma-facing components in NSTX-U* **Fusion Engineering and Design** 117 (2017) 135–139
- [20] S Kubota et al *A frequency-modulated continuous-wave reflectometer for the Lithium Tokamak Experiment* **Review of Scientific Instruments** 88 (2017) 053502
- [21] R Majeski et al *Observation of an isothermal electron temperature profile with low recycling lithium walls in LTX* **26th IAEA Fusion Energy Conference** (2016) EX/P3-34
- [22] JC Schmitt et al *High performance discharges in the Lithium Tokamak eXperiment with liquid lithium walls* **Physics of Plasmas** 22 (2015) 056112
- [23] M Lucia et al *Dependence of LTX plasma performance on surface conditions as determined by in situ analysis of plasma facing components* **Journal of Nuclear Materials** 463 (2015) 907
- [24] K Tritz et al *VUV/XUV measurements of impurity emission in plasmas with liquid lithium surfaces on LTX* **Plasma Physics and Controlled Fusion** 56 (2014) 125014
- [25] K Widmann et al *High-resolution grazing-incidence spectrometer for temperature measurements of low-Z ions emitting in the 100-300 Å spectral band* **Review of Scientific Instruments** 85 (2014) 11D630
- [26] R Majeski et al *Particle control and plasma performance in the Lithium Tokamak eXperiment* **Physics of Plasmas** 20 (2013) 056103
- [27] R Maingi et al *The nearly continuous improvement of discharge characteristics and edge stability with increasing lithium coatings in NSTX* **24th IAEA Fusion Energy Conference** (2012) EX/11-2
- [28] R Majeski et al *Results from LTX with Lithium-Coated Walls* **24th IAEA Fusion Energy Conference** (2012) ICC/P5-01
- [29] R Maingi, DP Boyle, JM Canik, SM Kaye, CH Skinner, et al, *The effect of progressively increasing lithium coatings on plasma discharge characteristics, transport, edge profiles, and ELM stability in NSTX* **Nuclear Fusion** 52 (2012) 083001
- [30] TK Gray et al *Spectral emission measurements of lithium on the lithium tokamak experiment* **Review of Scientific Instruments** 83 (2012) 10D537
- [31] R Maingi, SM Kaye, CH Skinner, DP Boyle, JM Canik, et al *Continuous improvement of H-mode discharge performance with progressively increasing lithium coatings in the National Spherical Torus Experiment* **Physical Review Letters** 107 (2011) 145004
- [32] R Maingi et al *Modification of edge profiles, edge transport, and ELM stability with lithium in NSTX* **23rd IAEA Fusion Energy Conference** (2010) EX/D2-2

Publications (contributing author)

- [33] X Zhang et al *Design and calibration of a retarding field energy analyzer for the LTX- β scrape off layer and modeling of electrostatic potential in a collisionless SOL* **Nuclear Materials and Energy** 19 (2019) 250–254
- [34] S Kubota et al *Millimeter-wave interferometry and far-forward scattering for density fluctuation measurements on LTX- β* **Review of Scientific Instruments** 89 (2018) 10H114
- [35] PE Hughes et al *Magnetic perturbation diagnostics in the high-temperature lithiated environment of LTX- β* **Review of Scientific Instruments** 89 (2018) 10J104
- [36] R Maingi et al *Effect of progressively increasing lithium conditioning on edge transport and stability in high triangularity NSTX H-modes* **Fusion Engineering and Design** 117 (2017) 150–156
- [37] JK Lepson et al *Responsivity calibration of the LoWEUS spectrometer* **Review of Scientific Instruments** 87 (2016) 11D614
- [38] R Maingi et al *Comparison of helium glow and lithium evaporation wall conditioning techniques in achieving high performance H-mode discharges in NSTX* **26th IAEA Fusion Energy Conference** (2016) EX/P4-38
- [39] SM Kaye et al *An overview of recent physics results from NSTX* **Nuclear Fusion** 55 (2015) 104002
- [40] R Maingi et al *Dependence of recycling and edge profiles on lithium evaporation in high triangularity high performance NSTX H-mode discharges* **Journal of Nuclear Materials** 463 (2015) 1134
- [41] M Lucia et al *Development progress of the Materials Analysis and Particle Probe* **Review of Scientific Instruments** 85 (2014) 11D835
- [42] SA Sabbagh et al *Overview of physics results from the conclusive operation of the National Spherical Torus Experiment* **Nuclear Fusion** 53 (2013) 104007
- [43] JC Schmitt et al *Results and future plans of the Lithium Tokamak eXperiment (LTX)* **Journal of Nuclear Materials** 438 (2013) S1096–S1099
- [44] A Diallo et al *Progress in characterization of the pedestal stability and turbulence during the edge-localized-mode cycle on NSTX* **Nuclear Fusion** 53 (2013) 093026
- [45] RJ Groebner et al *Improved understanding of physics processes in pedestal structure leading to improved predictive capability for ITER* **Nuclear Fusion** 53 (2013) 093024
- [46] Robert Kaita et al *Experiments with liquid metal walls: Status of the lithium tokamak experiment* **Fusion Engineering and Design** 85 (2010) 874-881
- [47] QR Marksteiner et al *Studies of a Parallel Force Balance Breaking Instability in a Stellarator* **AIP Conference Proceedings** 63 (2009) 63-68

Presentations (invited)

- [1] *Analysis of low recycling discharges with improved confinement and a hot edge in the Lithium Tokamak Experiment* **Exploratory Topics in Plasma and Fusion Research** 2017

Presentations (first-author)

- [2] *Confinement measurements in the Lithium Tokamak Experiment (LTX- β)* **47th EPS Conference on Plasma Physics** 2021
- [3] *Overview of Results and Plans at the Lithium Tokamak Experiment- β* **62nd APS DPP** 2020
- [4] *Impurity and transport measurements in LTX plasmas fully surrounded by liquified lithium surfaces* **61st APS DPP** 2019
- [5] *Impurity concentrations and transport in LTX plasmas fully surrounded by liquified lithium surfaces* **60th APS DPP** 2018
- [6] *Enhanced plasma and surface capabilities with beam fueling and heating in the Lithium Tokamak Experiment-Beta (LTX- β)* **23rd Plasma Surface Interactions** 2018
- [7] *Overview of Upgrades to the Lithium Tokamak Experiment, LTX- β* **59th APS DPP** 2017
- [8] *Measurements of impurity concentrations and transport in the Lithium Tokamak Experiment* **58th APS DPP** 2016
- [9] *Measurements of impurity concentrations and transport in the Lithium Tokamak Experiment* **22nd Plasma Surface Interactions** 2016
- [10] *Low impurity concentrations and enhanced confinement in the Lithium Tokamak Experiment (LTX)* **57th APS DPP** 2015
- [11] *Impurities in the Lithium Tokamak Experiment* **56th APS DPP** 2014
- [12] *Measuring the Effects of Lithium Wall-coatings on Impurities in LTX* **Exploratory Topics in Plasma and Fusion Research** 2014
- [13] *Effects of lithium wall-coatings on impurity ions in the Lithium Tokamak Experiment (LTX)* **41st IEEE International Conference on Plasma Science** 2014
- [14] *Improved doppler spectroscopy measurements on LTX* **55th APS DPP** 2013
- [15] *Passive CHERS measurements in the Lithium Tokamak Experiment (LTX)* **54th APS DPP** 2012
- [16] *Varying the pre-discharge lithium wall coatings to alter the characteristics of the ELM-free H-mode pedestal in NSTX* **20th Plasma Surface Interactions** 2012
- [17] *Evolution of ELM-free pedestal structure with lithium wall coatings in NSTX* **U.S. Transport Taskforce Workshop** 2012

- [18] *The relationships between ELM suppression, pedestal profiles, and lithium wall coatings in NSTX* **53rd APS DPP** 2011
- [19] *Edge profile and stability analysis as ELMs disappear with increasing lithium wall coatings in NSTX* **52nd APS DPP** 2010
- [20] *Eddy Currents and Magnetic Reconstruction in LDX* **51st APS DPP** 2009
- [21] *Electrostatic dust detector with improved sensitivity* **49th APS DPP** 2007

Media / Press releases

- [1] *First results of upgraded device highlight lithium's value for fusion* **Phys.org** July 29, 2020
- [2] *Machine set to see if lithium can help bring fusion to Earth* **Phys.org** May 2, 2019
- [3] *Researchers demonstrate first hot plasma edge in a fusion facility* **Phys.org** July 5, 2017
- [4] *Hotter All the Way: Lithium Wall Contains Plasma Without Cooling It* **DOE Fusion Energy Sciences Highlights** May 20, 2016
- [5] *More Lithium is Definitely Better* **American Physical Society** November 10, 2011

Awards & Honors

IOP Publishing Outstanding Reviewer Award, Plasma Physics and Controlled Fusion	2019
Publons Peer Review Award Top 1% in Physics	2018
U.S. Delegate to 60 th Meeting of Nobel Laureates and Young Researchers in Lindau	2010
U.S. Department of Energy Fusion Energy Sciences Fellowship	2008 – 2011
Faculty Award, Department of Applied Physics, Columbia University	2008
National Undergraduate Fellowship in Plasma & Fusion Energy Science	2007
Dean's List, Columbia University	2004 – 2008

Teaching

Preliminary Exam Review Course – Princeton University	2009
Led twice weekly review for plasma graduate students preparing for Physics Preliminary Exam	
NUF/SULI homework sessions – Princeton Plasma Physics Laboratory	2010 – 2017
Reviewed plasma physics problem sets with small groups of undergraduates	

Outreach Activities

U.S. Department of Energy National Science Bowl	2009 – Present
American Physical Society Plasma Sciences Expo	2009 – Present
Demonstrations at local events with PPPL Science Education	2010 – Present
LTX Visitor and Safety Tours	2011 – Present
“Fusion Day” outreach to United States Congress	2013, 2015

References

Richard Majeski
Ronald Bell
Rajesh Maingi
Robert Kaita
Vlad Soukhanovskii
Charles Skinner
Filippo Scotti
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