Egemen Kolemen

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Current Position

Princeton University, Princeton, NJ — Sep 2014 - present
Assistant Professor of Mechanical & Aerospace Engineering
Jointly appointed with the Andlinger Center for Energy and the Environment and the Princeton Plasma Physics Laboratory (PPPL)

Education

Princeton University, Princeton, NJ — Sep 2002 - Aug 2008
Ph.D. Mechanical & Aerospace Engineering

Bogazici University, Istanbul, Turkey — Sep 1998 - Jun 2002
B.S. Mechanical Engineering

Honors & Awards

Invited Speaker at IAEA Fusion Energy Conference, Russia — Oct 2014
Flagship fusion/plasma conference held every two years

Invited Speaker at IAEA Fusion Energy Conference, San Diego — Oct 2012
Flagship fusion/plasma conference held every two years

R&D 100 Award — Jun 2012
R&D Magazine's prestigious award for contribution to "snowflake power divertor" (co-recipients include Intel for work on second generation Intel Core processor, codenamed "Sandy Bridge")

Porter Ogden Jacobus Honorific Fellowship — Sep 2006 - Sep 2007
The highest honorific fellowship awarded by Princeton's Graduate School reserved for two to four students university-wide

Britt and Eli Harari Fellowship — Sep 2005 - Sep 2006
Awarded for academic excellence and research potential

Guggenheim Foundation Fellowship — Sep 2003 - Sep 2004
Awarded in recognition of excellence in research and coursework

Princeton University Graduate Fellowship — Sep 2002 - May 2003
Mechanical & Aerospace Engineering, Princeton University

Ranked 1st in Class of 2002 — Jun 2002
Mechanical Engineering graduating class, Bogazici University

Merit Scholarship, Bogazici University — Sep 1998 - May 2002

Ranked 1st in OSSY — Jun 1997
Turkish Nationwide University Entrance Exam, among ~1.5 million candidates

Experience

Collaborating Research Scientist — Jun 2011 – Aug 2014
DIII-D, General Atomics, San Diego, CA

(a) At DIII-D, I am leading the tearing mode suppression and avoidance experiments. In addition to the tearing mode physics, this project includes software and hardware development for the real-time electron cyclotron steerable mirror control. A new control system was built to direct the microwave power of the gyrotrons and suppress the plasma instabilities as they emerge. The task is achieved by fusing (1) measurements from multiple diagnostics such as motional Stark effect (MSE), Mirnov and Electron Cyclotron Emission (ECE) to identify the instabilities; (2) real-time density/temperature profile reconstruction; (3) real-time ray tracing to locate the power deposition location; (4) software for decision-making; and (5) control boards built in-house specifically for this purpose.

(b) I developed plasma divertor detachment and radiation control for DIII-D's advanced scenarios by integrating the divertor Thompson, Dβ, Dγ, bolometry and interferometry diagnostics.

(c) I developed "snowflake" advanced divertor scenarios. I implemented real-time snowflake calculation and control to obtain and stabilize different snowflake configurations.

(d) I implemented and commissioned burn control with non-axisymmetric coils. This includes the real-time β_N control with I/C coils and pedestal density control using Thomson data acquisition.

(e) Also, I developed dynamically β_N dependent error field control.

Control Expert — Jun 2011 - Aug 2014
ITER, Cadarache, France
Writing the kinetic control specifications for the ITER fusion reactor project with a group of international control experts.

Leader of the Operations and Control Group — Jun 2013 - present
Deputy Leader of the Operations and Control Group — Jun 2011 - Jun 2013
U.S. Burning Plasma Organization (burningplasma.org)
Advancing the scientific understanding of burning plasmas by coordinating U.S. fusion research with broad community participation.

Research Collaborator — Dec 2011 - present
The Korean Superconducting Tokamak Reactor (KSTAR), Daejon, Korea
Developing control algorithms for plasma startup and robust long pulse reactor operation. Developed the PCS shape control algorithm that enabled the first 10 second H-mode plasma.

Research Collaborator — Apr 2012 - present
Experimental Advanced Superconducting Tokamak (EAST), Hefei, China
Developing control logic for long pulse scenarios and assistance in the implementation of the electron cyclotron heating system.

Research Scientist — Oct 2011 - Aug 2014
Associate Research Scientist — Oct 2009 - Oct 2011
Princeton Plasma Physics Laboratory
Postdoctoral Research Fellow — Sep 2008 - Oct 2009
Princeton University
At PPPL, I developed reduced-order models suitable for designing feedback control laws for plasmas and experimentally tested these concepts on the National Spherical Torus Experiment (NSTX). In particular, I focused on the control of vertical-mode instabilities,

shape control, "snowflake" control, and rotation control using neutral beams and non-axisymmetric coils, which apply neoclassical toroidal viscosity, as actuators.

Instructor Sep 2008 - Jan 2009
Princeton University, MAE/Applied and Computational Mathematics
Taught MAE/APC-501, Mathematical Methods of Engineering Analysis, a mandatory course for all graduate students in MAE. Topics included Hilbert spaces, linear ODE/PDEs, Sturm-Liouville theory, Green's function, the calculus of variations, and the inverse and implicit function theorems.

Visiting Researcher Apr 2006 - Jun 2006
California Institute of Technology
Conducted research on the control and dynamics of the Terrestrial Planet Finder-Occulter Mission in Prof. Jerrold E. Marsden's group.

Visiting Researcher Feb 2006 - Apr 2006
Technion, Israel Institute of Technology
Conducted research on numerical methods to find invariant manifolds with Prof. Pini Gurfil.

Graduate Fellow/Research Assistant Sep 2002 - Aug 2008
Princeton University
My dissertation focused on the three main challenges of the Terrestrial Planet Finder-Occulter Mission: the dynamics of the formation, control and trajectory design of the satellites, and global optimization of the mission.

Teaching Assistant and Instructor Jan 2004 - Jan 2008
Princeton University
Aircraft Flight Dynamics, Automatic Control Systems, Differential Equations, Introduction to Dynamics, MATLAB Workshop & Orbital Mechanics.
Taught precepts and labs; prepared and graded assignments & exams; lectured.

Reviewer for Journals and Government Programs Ongoing
Selective list of journals and programs I review for include Physics of Plasmas; Fusion Energy Sciences Small Business Innovation Research / Small Business Technology Transfer (SBIR / STTR) program for the topical area of "Fusion Plasma Simulation and Data Analysis Tools"; Fusion Energy Sciences of the DOE Office of Science Early Career Research Program; Journal of Guidance, Control, and Dynamics; Fusion Engineering and Design; IEEE Transactions on Plasma Science; IEEE American Control Conference.

Computer Skills Matlab, Simulink, Fortran, C (supervising real-time C control algorithm development)

Publications

In Review/Preparation:

E. Kolemen et al., "Burning Plasma Relevant Control Development: Advanced Magnetic Divertor Configurations, Divertor Detachment and Burn Control", *Nuclear Fusion*, In review

E. Kolemen et al., "Heat flux management via advanced magnetic divertor configurations and divertor detachment", *Journal of Nuclear Materials*, In review.

E. Kolemen et al., "Snowflake Divertor Stability and Control at DIII-D and NSTX", *Nuclear Fusion*, To be submitted.

E. Kolemen et al., "Effects of Squareness on Stability and Performance on NSTX", *Nuclear Fusion*, In preparation.

E. Kolemen et al., "Vertical Stability of NSTX and NSTX-U", *Nuclear Fusion*, In preparation.

Refereed Publications:

[22] K. E. J. Olofsson, E. Kolemen et al., "Array magnetics modal analysis for the DIII-D tokamak based on localized time-series modeling", *Plasma Physics and Controlled Fusion*, Vol. 56, 095012, July 2014.

[21] E. Kolemen et al., "State-of-the-art Neoclassical Tearing Mode Control in DIII-D Using Real-Time Steerable Electron Cyclotron Current Drive Launchers", *Nuclear Fusion*, 073020, Vol. 54, May 2014.

[20] S. Hahn, E. Kolemen et al. "Progress and improvement of KSTAR plasma control using model-based control simulators", *Fusion Engineering and Design*, Vol. 89, Issue 5, pp. 542–547, May 2014.

[19] E. Kolemen et al., "Real-time Mirror Steering for Improved Closed Loop NTM Suppression by ECCD in DIII-D", *Fusion Engineering and Design*, Vol. 88, pp. 2757-2760, Mar. 2013.

[18] V. A. Soukhanovskii, E. Kolemen et al., "Advanced divertor configurations with large flux expansion", *Journal of Nuclear Materials*, Vol. 438, pp. 96-101, July 2013.

[17] J. Menard, E. Kolemen et al., "Overview of the physics and engineering design of NSTX upgrade", *Nuclear Fusion*, Vol. 52, 083015, July 2012.

[16] V. A. Soukhanovskii, E. Kolemen et al., "Snowflake divertor configuration studies in National Spherical Torus Experiment", *Physics of Plasmas*, Vol. 19, 082504, 2012.

[15] E. Kolemen, D. A. Gates et al., "Plasma modelling results and shape control improvements for NSTX", *Nuclear Fusion*, Vol. 51, 113024, Nov. 2011.

[14] S. P. Gerhardt, E. Kolemen et al., "Implementation of β_N Control in the National Spherical Torus Experiment", *Fusion Science and Technology*, Vol. 61, pp. 11-18, Feb. 2012.

[13] E. Kolemen & N. J. Kasdin, "Optimization of an Occulter-Based Extrasolar-Planet-Imaging Mission", *Journal of Guidance, Control, and Dynamics*, Vol. 35, Issue 1, pp. 172-185, Jan. 2012.

[12] E. Kolemen, N. J. Kasdin & P. Gurfil, "Multiple Poincare Sections Method for Finding the Quasi-Periodic Orbits of the Restricted Three Body Problem", *Celestial Mechanics and Dynamical Astronomy*, Vol. 111, Issue 4, pp. 1-28, Nov. 2011.

[11] R. Raman, E. Kolemen et al., "Overview of physics results from NSTX", *Nuclear Fusion*, Volume 51, Issue 9, 094011, Sep. 2011.

[10] S. P. Gerhardt, E. Kolemen et al., "Recent progress toward an advanced spherical torus operating point in NSTX", *Nuclear Fusion*, Vol. 51, Issue 7, 073031, July 2011.

[9] V. A. Soukhanovskii, E. Kolemen et al., “Taming the plasma-material interface with the 'snowflake' divertor in NSTX”, *Nuclear Fusion*, Vol. 51, Issue 1, 012001, Jan. 2011.

[8] E. Kolemen, D. A. Gates et al., “Strike point control for the National Spherical Torus Experiment (NSTX)”, *Nuclear Fusion*, Vol. 50, Issue 10, 105010, Sep. 2010.

[7] V. A. Soukhanovskii, E. Kolemen et al., “Snowflake divertor configuration in NSTX”, *Journal of Nuclear Materials*, Aug. 2010.

[6] D. A. Humphreys, E. Kolemen et al., “Experimental vertical stability studies for ITER performance and design guidance”, *Nuclear Fusion*, Vol. 49, 115003, Nov. 2009.

[5] D. A. Gates, E. Kolemen et al., “Overview of results from the National Spherical Torus Experiment (NSTX)”, *Nuclear Fusion*, Vol. 49, Issue 10,104016, Oct. 2009.

[4] R. J. Vanderbei & E. Kolemen, “Linear Stability of Ring Systems”, *Astronomical Journal*, Vol. 133, Issue 2, pp. 656-664, 2007.

[3] P. Gurfil, N. J. Kasdin & E. Kolemen, “Hamilton-Jacobi Modeling of Stellar Dynamics”, *Advances in Space Research*, Vol. 36, No. 6, pp.1143-1150, 2005.

[2] E. Kolemen, N. J. Kasdin & P. Gurfil, “Hamilton-Jacobi Modelling of Relative Motion for Formation Flying”, *Annals of the New York Academy of Sciences*, Vol. 1065, pp. 93-111, Dec. 2005.

[1] N. J. Kasdin, P. Gurfil & E. Kolemen, “Canonical Modeling of Relative Spacecraft Motion via Epicyclic Orbital Elements”, *Celestial Mechanics and Dynamical Astronomy*, Vol. 92, Issue 4, pp. 337-370, 2005.

Proceedings:

[7] E. Kolemen et al., “Heat Flux Management via Advanced Magnetic Divertor Configurations and Divertor Detachment ”, eNews, USBPO, Issue 79, Dec. 2013, pp. 3- 8

[6] E. Kolemen & N. J. Kasdin, “Optimal Trajectory Control of an Occulter Based Planet Finding Telescope”, *Advances in Astronautical Sciences*, AAS 07-037, Vol. 128, pp. 215-233, 2007.

[5] E. Kolemen & N. J. Kasdin, “Optimal Configuration of a Planet-Finding Mission Consisting of a Telescope and a Constellation of Occulters”, *Advances in Astronautical Sciences*, AAS 07-202, Vol. 127, pp. 1503-1524, 2007.

[4] E. Kolemen & N. J. Kasdin, “Dynamics and Control of a Space Based Extra-Solar Planet Imaging Mission Consisting of a Telescope and Multiple Occulters”, *Society of Photographic Instrumentation Engineers Conference Proceedings*, SPIE 6687-38, Aug. 2007.

[3] E. Kolemen, N. J. Kasdin & P. Gurfil, “Quasi-Periodic Orbits of the Restricted Three Body Problem Made Easy”, *AIP Conference Proceedings,* Vol. 886, pp. 68-77, 2006.

[2] N. J. Kasdin & E. Kolemen, “Bounded, Periodic Relative Motion using Canonical Epicyclic Orbital Elements”, *Advances in the Astronautical Sciences*, *Spaceflight Mechanics*, Vol. 120, No. 2, pp. 1381-1398, 2005.

[1] E. Kolemen & N. J. Kasdin, "Relative Spacecraft Motion: A Hamiltonian Approach to Eccentricity Perturbations", *Advances in the Astronautical Sciences, Spaceflight Mechanics*, Vol. 119, pp. 3075-3085, 2005.

Presentations

Invited Speaker:

[4] E. Kolemen et al., "Burning Plasma Relevant Control Development: Advanced Magnetic Divertor Configurations, Divertor Detachment and Burn Control", Invited Speaker at *IAEA Fusion Energy Conference*, St. Petersburg, Russia, Oct. 2014.

[3] E. Kolemen et al., "Neoclassical Tearing Mode Control and Stabilization in Steady State Burning Plasma", Invited Speaker at *18th MHD Workshop*, Santa Fe, NM, Nov. 2013.

[2] E. Kolemen et al., "Neoclassical tearing mode control by electron cyclotron current drive using dynamic alignment to access higher performance", Invited Speaker at *XX Topical Conference on Radiofrequency Power in Plasmas*, Sorrento, Italy, June 2013.

[1] E. Kolemen et al., "State-of-the-art Neoclassical Tearing Mode Control in DIII-D Using Real-Time Steerable Electron Cyclotron Current Drive Launchers", Invited Speaker at *IAEA Fusion Energy Conference*, San Diego, USA, Oct. 2012.

Conference Presentations:

[39] E. Kolemen et al., "Divertor Optimization via Control at DIII-D", *American Physical Society Division of Plasma Physics Meeting*, New Orleans, LA, Nov. 2014.

[38] R. Hawryluk, E. Kolemen et al., "Experimental Simulation of Burn Control Using DIII-D In-Vessel Coils", *IAEA Fusion Energy Conference*, St. Petersburg, Russia, Oct. 2014.

[37] J. Ferron, "High Internal Inductance for Steady-State Operation in ITER and a Reactor", *IAEA Fusion Energy Conference*, St. Petersburg, Russia, Oct. 2014.

[36] R. Nazikian, "Recent Advances in the Understanding and Optimization of RMP ELM Suppression for ITER", *IAEA Fusion Energy Conference*, St. Petersburg, Russia, Oct. 2014.

[35] V. Soukhanovskii, "Developing Physics Basis for the Radiative Snowflake Divertor at DIII-D", *IAEA Fusion Energy Conference*, St. Petersburg, Russia, Oct. 2014.

[34] A. G. McLean, "Midplane Separatrix Requirements for Achieving Divertor Detachment in DIII-D", *IAEA Fusion Energy Conference*, St. Petersburg, Russia, Oct. 2014.

[33] T. W. Petrie, "Applying the Radiating Divertor Approach to Innovative Tokamak Divertor Concepts", *IAEA Fusion Energy Conference*, St. Petersburg, Russia, Oct. 2014.

[32] D. Mueller, "Improvements in the Fast Vertical Control Systems in KSTAR, EAST, NSTX, and NSTX-U", *IAEA Fusion Energy Conference*, St. Petersburg, Russia, Oct. 2014.

[31] E. Kolemen et al., "Heat flux management via advanced magnetic divertor configurations and divertor detachment", Oral Presentation at *the International Conference on Plasma Surface Interactions (PSI),* Kanazawa, Japan, May 2014.

[30] E. Kolemen et al., "Advanced Divertor Developments at DIII-D", *American Physical Society Division of Plasma Physics Meeting*, Denver, CO, Nov. 2013.

[29] Z. Ilhan, E. Kolemen et al., "Physics-based Control-oriented Modeling of the Current Profile Evolution in NSTX-Upgrade", *American Physical Society Division of Plasma Physics Meeting*, Denver, CO, Nov. 2013.

[28] D. Mueller, E. Kolemen et al., "Improvements to the vertical control of KSTAR", *American Physical Society Division of Plasma Physics Meeting*, Denver, CO, Nov. 2013.

[27] E. Kolemen et al., "Results from the state-of-the-art NTM control and initial snowflake divertor studies at DIII-D", *Presented at the École Polytechnique Fédérale de Lausanne*, Lausanne, Switzerland Jan. 2013.

[26] E. Kolemen et al., "Neoclassical Tearing Mode Control System with Real-time Mirror Steering: Implementation and Results from DIII-D", *Presented at the Max Plank Institute*, Garching, Germany Jan. 2013.

[25] E. Kolemen et al., "Vertical Stability of NSTX and NSTX-U", *IAEA Fusion Energy Conference*, San Diego, USA Oct. 2012.

[24] V. A. Soukhanovskii, E. Kolemen et al., "Snowflake Divertor as Plasma-Material Interface for Future High Power Density Fusion Devices", *IAEA Fusion Energy Conference*, San Diego, USA Oct. 2012.

[23] E. Kolemen et al., "NTM Suppression and Avoidance at DIII-D Using Real-Time Mirror Steering", *American Physical Society Division of Plasma Physics Meeting*, Providence, RI, Oct. 2012.

[22] V. A. Soukhanovskii, E. Kolemen et al., "Divertor Scenarios for NSTX-U", *American Physical Society Division of Plasma Physics Meeting*, Providence, RI, Oct. 2012.

[21] E. Kolemen et al., "Real-time Mirror Steering for Improved Closed Loop NTM Suppression by ECD in DIII-D", *27th Symposium on Fusion Technology*, Liege, Belgium, Sep. 2012.

[20] E. Kolemen et al., "NTM Suppression and Avoidance via Real-time Mirror Steering using ECE Diagnostic at DIII-D", *Presented at the Institute of Plasma Physics*, Hefei, China, June 2012.

[19] E. Kolemen, et al., "Control Development for NSTX and the Effects of Strong Shaping", *American Physical Society Division of Plasma Physics Meeting*, Salt Lake City, Nov. 2011.

[18] V. A. Soukhanovskii, E. Kolemen et al., "Snowflake divertor configuration studies for NSTX-Upgrade", *American Physical Society Division of Plasma Physics Meeting*, Salt Lake City, Nov. 2011.

[17] M. L. Walker, E. Kolemen et al., "System Modeling, Validation, and Design of Shape Controllers for NSTX", *American Physical Society Division of Plasma Physics Meeting*, Salt Lake City, Nov. 2011.

[16] V. A. Soukhanovskii, E. Kolemen et al., "The snowflake divertor: a game-changer for magnetic fusion devices? ", *38th EPS Conference on Plasma Physics*, June 2011.

[15] J. Menard, E. Kolemen et al., "Overview of the physics and engineering design of NSTX upgrade", *Fusion Engineering (SOFE)*, pp. 1-8, June 2011

[14] E. Kolemen, D. A. Gates, S. Gerhardt, J. Menard, V. Soukhanovskii, "NSTX Advanced Scenarios and Control Overview", *Sixth IAEA Technical Meeting on Steady State Operation of Magnetic Fusion Devices*, Vienna, Austria, Dec. 2010.

[13] E. Kolemen, D. A. Gates et al., "Plasma Modeling Results, Control Improvement for NSTX and Applications to ITER", *IAEA Fusion Energy Conference*, Seoul, Korea, Oct. 2010.

[12] V. A. Soukhanovskii, E. Kolemen et al., "Synergy Between Lithium Plasma-Facing Component Coatings and the Snowflake Divertor Configuration in NSTX", *IAEA Fusion Energy Conference*, Seoul, Korea Oct. 2010.

[11] E. Kolemen, D. A. Gates, S. Gerhardt, R. Kaita, J. Kallman, H. Kugel, D. Mueller, V. Soukhanovskii, "Results of the NSTX Shape Control Experiments", *American Physical Society Division of Plasma Physics Meeting*, Chicago, Nov. 2010.

[10] A.S. Welander, E. Kolemen et al, "Linear Plasma Response Model Based on the Solution to a Perturbed Grad-Shafranov Equation", *American Physical Society Division of Plasma Physics Meeting*, Chicago, Nov. 2010.

[9] W. Shi, E. Schuster, M. L. Walker, D. A. Humphreys, D. Gates and E. Kolemen, "Multivariable Model-based Shape Control for the National Spherical Torus Experiment", *American Physical Society Division of Plasma Physics Meeting*, Chicago, Nov. 2010.

[8] E. Kolemen, D. Gates, C. W. Rowley & N. J. Kasdin, "NSTX Strike Point Position Control", *American Physical Society Division of Plasma Physics Meeting*, Atlanta, Nov. 2009.

[7] K. Taira, E. Kolemen, D. Gates, C. W. Rowley & N. J. Kasdin, "Rotational Control of Plasma in NSTX", *American Physical Society Division of Plasma Physics Meeting*, Atlanta, Nov. 2009.

[6] E. Kolemen & D. A. Gates, "Maximum Controllable Displacement: Experimental Results from NSTX, and Comparison with Theoretical Results and Other Tokamaks", *American Physical Society Division of Plasma Physics Meeting*, Dallas, Nov. 2008.

[5] D. A. Humphreys, E. Kolemen et al., "ITER Vertical Stability Guidance from Multi-machine Experiments", *Bulletin of American Physics Society*, 53, 84, Nov. 2008.

[4] D. A. Humphreys, E. Kolemen et al., "Experimental Vertical Stability Studies for ITER Performance and Design Guidance", *Proceedings of the 22nd IAEA Fusion Energy Conference*, Geneva, Switzerland, Oct. 2008.

[3] E. Kolemen & N. J. Kasdin, "Dynamics of an Occulter Based Planet-Finding Telescope", *Bulletin of the American Astronomical Society*, Vol. 38, p. 1132.

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[1] E. Kolemen & N. J. Kasdin, "Filtering of an Interceptor Mission with a Weaving

Target", *SBIR presentation Egland Air Force Base*, Sep. 2004.

References Available upon request