MICHAEL D. LITOS

Curriculum Vitae, Feb. 1, 2025

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EMPLOYMENT

University of Colorado Boulder *Sep. 2024 - Present*
Associate Professor, Department of Physics
University of Colorado Boulder *Sep. 2016 - Aug. 2024*
Assistant Professor, Department of Physics
SLAC National Accelerator Laboratory *Nov. 2014 - Aug. 2016*
Associate Staff Scientist
SLAC National Accelerator Laboratory *July 2010 - Oct. 2014*
Postdoctoral Research Associate

EDUCATION

Boston University *July 2003 - May 2010*
Doctor of Philosophy: Physics
Thesis: *A Search for Dinucleon Decay into Kaons Using The Super–Kamiokande Water Cherenkov Detector*
Thesis Advisor: Prof. Ed Kearns
Michigan State University *Sep. 1998 - June 2003*
Bachelor of Science: Physics
Additional Major: East Asian Studies (Japanese)

EXTERNAL FUNDING

$345k (Univ. of Colorado portion), 2024-2026
PI: Michael Litos (submitted with Radiabeam Technologies)
US DOE Office of Science, Office of High Energy Physics SBIR/STTR Program Phase Two
Beam Position Monitor for High Intensity Environments.

$61k (Univ. of Colorado portion), 2023-2024
PI: Michael Litos (submitted with Radiabeam Technologies)
US DOE Office of Science, Office of High Energy Physics SBIR/STTR Program Phase One
Beam Position Monitor for High Intensity Environments.

$445k, 2023-2026
PI: Michael Litos, Co-PIs: Dan Dessau, Christine Morrow
NSF Directorate for Mathematical and Physical Sciences
REU Site: Physics/JILA.

$690k, 2021-2026
Single PI: Michael Litos
NSF Early Career Award Program
CAREER: Coherent Radiation Production in an Ion Channel Laser.

$1.26M, 2024-2028
PI: Micheal Litos, Co-PI: John Cary
US DOE Office of Science, Office of High Energy Physics
Emittance Preservation in a Plasma Wakefield Accelerator and Hard Focusing with a Thin Plasma Lens.

$1.15M, 2020-2024
PI: Micheal Litos, Co-PI: John Cary
US DOE Office of Science, Office of High Energy Physics
Emittance Preservation in a Plasma Wakefield Accelerator, Hard Focusing with a Thin Plasma Lens, and Demonstration of an Ion Channel Laser.

$1.1M, 2017-2020
PI: Micheal Litos, Co-PI: John Cary
US DOE Office of Science, Office of High Energy Physics
Plasma Source Development for Beam Emittance Preservation in a Plasma Wakefield Accelerator.

$220k, 2018-2020
PI: Michael Litos, Co-PI: Tobin Munsat
NSF/DOE Partnership in Basic Plasma Science and Engineering
High-Speed, High-Resolution Diagnostic System for a Plasma Wakefield Accelerator.

$17k, 2018
Single PI: Michael Litos
NSF Directorate for Mathematical and Physical Sciences
Student Participation Support for 2018 Advanced Accelerator Concepts Workshop.
Used for student support at the AAC 2018 workshop in Breckenridge, CO.

AWARDS AND RECOGNITION

National Science Foundation Early Career Award 2020.

Breakthrough Prize in Fundamental Physics (Super-Kamiokande and T2K Collaborations) 2016.

Okemos Education Foundation Distinguished Alumni Award 2016.

RESEARCH HIGHLIGHTS

University of Colorado Boulder

Associate Professor, 2024 – Present
Assistant Professor, 2016 – 2024

Principal investigator for research into plasma wakefield acceleration and related topics with a focus on experimental programs at SLAC National Accelerator Laboratory's Facility for Advanced Accelerator Experimental Tests-II (FACET-II). In charge of terawatt-scale university laser lab. Leader of university research group of roughly five members, graduate and undergraduate. Typical collaboration size for each FACET-II experiment is ten-to-fifteen people. Research group and collaborative accomplishments from this period of research follow.

- Establishment of first experimental plasma accelerator research group on campus.
- Establishment of first high-power (10 terawatt) research laser lab on campus.
- Principal investigator for 3 experiments at FACET-II:
  - E301 - Beam Emittance Preservation in a Laser-Ionized Gas Plasma Wakefield Accelerator (commissioning phase)
  - E308 - Hard Focusing of a Relativistic Electron Beam with a Thin, Underdense, Passive Plasma Lens (commissioning phase)
  - E306 - Experimental Demonstration of an Ion Channel Laser (planning phase)

- Collaborator on more than a dozen additional experiments related to plasma wakefield acceleration at FACET-II. General themes include:
  - Beam loading studies in plasma accelerators
  - Beam breakup (hosing) instability studies in plasma accelerators
  - High brightness beam injection in plasma accelerators by various mechanisms:
    * Density downramp injection
    * Beam ionization injection
    * Laser ionization injection
  - Relativistic plasma filamentation (laboratory plasma astrophysics)
  - Strong-field transition radiation interactions
  - Probing of strong-field quantum electrodynamics
  - Advanced diagnostics for measurement of the plasma accelerator wake structure
  - Acceleration of positrons in a plasma wakefield accelerator
  - Applications of machine learning to plasma wakefield accelerators
- Advancement of the analytic theory describing chromatic transverse beam dynamics in plasma wakefield accelerators, essential for beam emittance preservation.
- Development of fast particle-tracking and betatron radiation simulation code for nonlinear plasma wakefield accelerators.
- Development of novel laser-reliant techniques to generate advanced plasma sources for use in plasma wakefield acceleration necessary for emittance preservation.
- Development of novel plasma diagnostic schemes for wakefield accelerator plasma sources using inexpensive equipment appropriate for high radiation environments.
- Development of theoretical and experimental concept for thin, underdense, passive plasma lens able to produce the strongest possible focusing of electron beams.
- Advancement of the analytic theory describing beam dynamics in a nonlinear plasma wakefield accelerator with a transverse density gradient.
- Development of novel ultrafast photonic diagnostic (electro-optic sampling beam position monitor) for single-shot, nondestructive, 3D profile retrieval of relativistic electron beams.
- Development of physics case for the first experimental demonstration of an ion channel laser: a plasma-based analog of the free electron laser.
- Participation in experimental planning, design, installation, and commissioning efforts at FACET-II.

SLAC National Accelerator Laboratory

Associate Staff Scientist: 2014 – 2016
Postdoctoral Research Associate: 2010 – 2014, Supervisor: Dr. Mark Hogan

Participated in planning, coordination, execution, and analysis for nearly all experiments carried out at SLAC's Facility for Advanced Accelerator Experimental Tests (FACET) over the lifetime of the facility. Typical collaboration size for each experiment was roughly ten people. Collaborative accomplishments from this period of research follow.

- Demonstration of high-gradient, high-efficiency plasma wakefield acceleration for the first time. First author of corresponding publication in the journal Nature, which was featured on the cover of the issue.
- Achievement of record for highest energy gain in a plasma-based accelerator (9 GeV energy gain in 1.3 meters). First author of corresponding publication.
- Discovery of nonlinear regime of plasma wakefield acceleration for positron beams.
- Demonstration of multiple high-brightness beam injection techniques, including beam ionization injection and laser ionization injection ("Trojan Horse").
- Demonstration of hollow-channel plasma wakefield accelerator using positron bunches and measured the corresponding longitudinal and transverse wakefields.
- Measurement of the electromagnetic field structure inside a nonlinear blowout plasma wakefield accelerator.
- Demonstration of high-gradient plasma wakefield acceleration in a beam-ionized high-ionization threshold gas.
- Measurement of long-range force acting on an electron beam passing near a neutral plasma column.

Boston University

Graduate Research Assistant: 2003 – 2010, Supervisor: Prof. Ed Kearns

Member of the Super-Kamiokande and T2K collaborations. Participated in neutrino oscillation and nucleon decay analysis in addition to detector hardware and software upgrades. Collaboration sizes were roughly a few hundred each. Individual accomplishments from this period of research follow.

- Development of Geant-4 simulation of a proposed near detector for T2K.
- First search for dinucleon decay into charged kaons using Super-K data and established the standing limit for R-Parity violating, $\Delta B = 2$ decay process $pp \to K^+K^+$.
- Development of first algorithm to identify and locate multiple particle vertices for a single event in a water Cherenkov detector.
- Performance of first multi-variate (machine learning) analysis of Cherenkov detector data using a boosted decision tree.
- Design, construction, and installation of detector monitor hardware at Super-K.
- Participation in water Cherenkov detector upgrade for SK-III at Super-K.

TEACHING, ACADEMIC, AND SUPERVISION ACTIVITIES

Courses Taught at the University of Colorado Boulder:

Semester	Course Number	Course Title
2016 Fall	PHYS 3300	Intro to Electronics Lab
2017 Spring	PHYS 2170	Gen. Physics III: Intro to Modern Physics
2017 Fall	PHYS 2170	Gen. Physics III: Intro to Modern Physics
2018 Spring	PHYS 2020	Gen. Physics II: Elec. and Mag. (Non-Majors)
2018 Fall	PHYS 4150	Intro to Plasma Physics
2019 Spring	PHYS 2020	Gen. Physics II: Elec. and Mag. (Non-Majors)
2020 Spring	PHYS 2170	Gen. Physics III: Intro to Modern Physics
2020 Fall	PHYS 1115	Gen. Physics I: Classical Mechanics (Majors)
2021 Spring	PHYS 5150	Graduate Plasma Physics I
2021 Fall	PHYS 1115	Gen. Physics I: Classical Mechanics (Majors)
2022 Spring	PHYS 5150	Graduate Plasma Physics I
2022 Fall	PHYS 4150	Intro to Plasma Physics
2023 Spring	PHYS 3330	Intro to Electronics Lab
2023 Fall	PHYS 4150	Intro to Plasma Physics
2024 Spring	PHYS 3330	Intro to Electronics Lab
2024 Fall	PHYS 4150	Intro to Plasma Physics

Courses Taught at the United States Particle Accelerator School:

Session	Role	Course Title
2016 Jan. Session	Co-Instructor	Particle-Driven Wakefield Accelerators
2020 Jan. Session	Co-Instructor	Particle-Driven Wakefield Accelerators
2022 June Session	Co-Instructor	Particle-Driven Plasma Wakefield Accelerators

Student Research Supervision:

- Current advisor to four CU physics Ph.D. graduate students (Valentina Lee, Claire Hansel, Elena Ros, and Shutang Meng)
- Graduated two physics Ph.D. students (Robert Ariniello in 2022 and Christopher Doss in 2023)
- Graduated one physics masters student (Keenan Hunt-Stone in 2020 to pursue law degree)
- Current research supervisor to two CU undergraduate students, including one honors student
- Supervised nine CU physics undergraduate and post-bachelor research assistants (2017-present)
- Graduated four physics undergraduate students with honors (cum laude and magna cum laude in 2019, summa cum laude in 2023 and 2024)
- Supervised four physics REU students (one each year 2021–2024)

PROFESSIONAL SERVICE ACTIVITIES

Departmental Committee Work:
Participant in various committees within the Physics Department at the University of Colorado Boulder, including junior faculty committee, engineering physics advising committee, merit evaluation committee, APS site visit committee, graduate committee, graduate program revision committee, and graduate program revision implementation committee (chair). In addition, coordinator of the NSF Physics/JILA REU program (2020-present) and member of the 2022 plasma theory faculty hiring committee.

Research Center Administration:
Director of the Center for Integrated Plasma Studies, July 2023 - present.
Associate Director of the Center for Integrated Plasma Studies, May 2017 - June 2023.

Professional Society Memberships:
American Physical Society 2010 - present; *IEEE* 2018 - present.

Journal Referee Work:
Refereed manuscripts for the following journals: *Nature; Nature Physics; Nature Scientific Reports; AAAS Science Advances; Physical Review Letters; Physical Review E; Physical Review Accelerators and Beams; IEEE Proceedings; Nuclear Instruments and Methods A; Physics Letters A.*

Grant Proposal and Award Review:
Reviewed the following types of research grant proposals for the US DOE Office of Science, 2016 – present: *SBIR Phase 1 and 2; High Energy Physics; High Energy Density Laboratory Plasma Physics; Accelerator Stewardship; Early Career Award; Office of Science Graduate Student Research Program.*

Reviewed the following types of research grant proposals for the National Science Foundation, 2016 – present: *Major Research Instrumentation (MRI) Program; Plasma Physics Program.*

Participated in comparative review panel for the US DOE Office of Science for *Accelerator Stewardship* research grant applications in 2018 and for the NSF *Plasma Physics Program* research grant applications in 2023 and 2024.

Reviewed a research grant proposal for the Agence Nationale de la Recherce (France) in 2019.

Reviewed a research grant proposal for the Deutsche Forschungsgemeinschaft (Germany) in 2022.

Conference and Workshop Organization:
Founder and organizer of annual *Colorado Plasma Retreat*, located at Boulder Chautauqua, CO, initiated Aug. 2021; ongoing. Supported by NSF Career Award.

Program committee member for *American Physical Society Division of Plasma Physics (APS DPP) Meeting*, Spokane, Washington, November 17-21, 2022.

Organizing committee member for *Physics and Applications for High Brightness Beams Workshop 2019*, Crete, Greece, April 8-12, 2019.

Organizing committee member for *Advanced Accelerator Concepts Workshop 2018*, Breckenridge, CO, Aug. 12-17, 2018. Obtained $17k student support grant through NSF.

Working Group Leader for *Advanced Accelerator Concepts Workshop*: Beam-Driven Plasma Wakefield Acceleration Working Group, Washington, D.C., July 31-Aug. 5, 2016.

Working Group Leader for *Laser and Plasma Accelerator Workshop*: Beam-Driven Plasma Wakefield Acceleration Working Group, Goa, India, Sep. 2-6, 2013.

Research Funding Roadmap Workshops:
Coauthor of multiple white papers submitted to the American Physical Society Division of Particles and Fields (APS DPF) Snowmass 2021 Particle Physics Community Planning Exercise under working group Accelerator Frontiers 6: Advanced Accelerator Concepts.

First author and coordinator of white paper submitted to The National Academy of Sciences, Engineering, and Medicine for the Plasma 2020 Decadal Assessment, entitled *"Survey of Particle Beam-Driven Plasma Wakefield Acceleration Research"*. Submitted March 8, 2019.

Invited Participant at U.S. Department of Energy Workshop: *"Workshop to Chart a Roadmap for Advanced Accelerators"*, Washington, D.C., Feb. 2-3, 2016.

Facility Scientific Planning Workshops:
Invited Participant at FACET-II Planning Advisory Committee Meeting, SLAC National Accelerator Laboratory, annually 2015-present.

Design Study Working Groups:
Beam delivery system working group leader for international *10 TeV Wakefield Collider Design Study*, 2024-present.

INVITED PRESENTATIONS SINCE 2016

1. Western Kentucky University Physics Colloquium, *Miniaturizing Particle Accelerators with the Power of Plasma*, given over Zoom, March 4, 2024.
2. University of Colorado Boulder Physics Colloquium, *The Power of Plasma: Extending the energy frontier and democratizing X-ray lasers*, University of Colorado Boulder, Boulder, CO, Sep. 27, 2023.
3. European Advanced Accelerator Concepts (EAAC) Workshop 2023, *Free electron lasers driven by plasma accelerators: status and near-term perspectives*, La Biodola Bay, Isola d'Elba, Italy, Sep. 20, 2023.
4. Idaho State University Physics Colloquium, *Big Energy from Tiny Waves: Plasma Wakefield Accelerator Research at FACET-II*, given over Zoom, Aug. 22, 2023.
5. SLAC DOE OOS OHEP Institutional Review 2022, *User Experience at FACET-II: Past Experience and Future Opportunities*, SLAC National Accelerator Laboratory, Menlo Park, CA, Oct. 20, 2022.
6. APS Four Corners Section (4CS) Meeting 2022, *Big Energy from Tiny Waves: Plasma Wakefield Accelerator Research at FACET-II*, University of New Mexico, Albuquerque, NM, Oct. 14, 2022.
7. NSF Ecosystem for Collaborative Leadership and Inclusive Innovation in Plasma Science and Engineering (ECLIPSE) Meeting 2022, *Plasma Accelerators and Ion Channel Lasers at FACET-II*, Alexandria, VA, March 10, 2022 [poster presentation].
8. Colorado State University Physics Colloquium, *"Big Energy from Tiny Waves: Plasma Wakefield Accelerator Research at FACET-II"*, Colorado State University, Fort Collins, CO, Oct. 4, 2021.
9. Colorado Plasma Summer Retreat 2021, *"Plasma-Based Accelerators"*, Boulder Chautauqua, Boulder, CO, Aug. 13, 2021.
10. APS Four Corners Section (4CS) Meeting 2021, *"Plasma Wakefield Accelerator Research at FACET-II"*, University of Colorado Boulder, Boulder, CO, Oct. 9, 2021.
11. Accelerator on a Chip International Program (ACHIP) Meeting 2020, *"Plasma-Based Accelerators"*, University of Colorado Boulder, Boulder, CO, Mar. 12, 2020.
12. CU Boulder Saturday Physics Lecture Series, *Harnessing the Power of Plasma to Build the Particle Accelerators of the Future*, University of Colorado Boulder, Boulder, CO, Nov. 2, 2019.
13. Scientific Meeting of the Royal Society: Directions in particle beam-driven plasma wakefield acceleration, *"Beam Quality Preservation Challenges and Strategies"*, Kavli Royal Society Centre, Chicheley Hall, Newport Pagnell, UK, June 4-5, 2018.
14. Fermilab Workshop on Megawatt Rings & IOTA/FAST, *"Plasma Beam Modulator and Afterburner at FAST"*, Fermi National Accelerator Laboratory, Batavia, IL, May 7-10, 2018.
15. LOA Physics Seminar, *"Plasma Wakefield Acceleration Experiments at FACET"*, Laboratoire d'Optique Appliqueé , Palaiseau, France, July 17, 2017.

16. CU Boulder Physics Colloquium, *"Plasma Wakefield Acceleration: Surfing on a Wave of Plasma"*, University of Colorado Boulder, Boulder, CO, Feb. 25, 2016.

17. SLAC DOE OOS OHEP Institutional Review 2016, *FACET PWFA Program - Electrons*, SLAC National Accelerator Laboratory, Menlo Park, CA, June 7-9, 2016.

SELECTED PUBLICATIONS SINCE 2016

My name and those of my CU graduate students have been underlined.

1. D. Storey, et al., "Wakefield generation in hydrogen and lithium plasmas at FACET-II: Diagnostics and first beam-plasma interaction results", Phys. Rev. Accel. Beams 27, 051302 (2024)

2. C. Zhang, et al., "Generation of meter-scale hydrogen plasmas and efficient, pump-depletion-limited wakefield excitation using 10-GeV electron bunches", Plasma Physics and Controlled Fusion 66, 025013 (2024)

3. V. Lee, et al., "Temporal evolution of the light emitted by a thin, laser-ionized plasma source", Phys. Plasmas 31, 013104 (2024)

4. A. Matheron, et al., "Probing strong-field QED in beam-plasma collisions", Communications Physics 6, 141 (2023)

5. S. Gessner, et al., "Acceleration of a Positron Bunch in a Hollow Channel Plasma", arXiv:2304.01700 (2023) [submitted to Communications Physics]

6. C. Doss, et al., "Underdense Plasma Lens with a Transverse Density Gradient", Physical Review Accellerators and Beams 26, 031302 (2023)

7. A. F. Habib, et al., "Attosecond-Angstrom free-electron-laser towards the cold beam limit", Nature Communications 14, 1054 (2023)

8. T. Barklow, et al., "Beam delivery and beamstrahlung considerations for ultra-high energy linear colliders", JINST 18, P09022 (2023)

9. E. A. Nanni, et al., "Status and future plans for C3 R&D", JINST 18, P09040 (2023)

10. M. Litos, "News & Views: Plasmas primed for rapid pulse production", Nature 603, 34-35 (2022)

11. R. Ariniello, C. E. Doss, V. Lee, C. Hansel, J. R. Cary, and M. D. Litos, "Chromatic Dynamics of an Electron Beam in a Plasma Based Accelerator", Physical Review Research 4, 043120 (2022)

12. G. White, et al., "Beam delivery and final focus systems for multi-TeV advanced linear colliders", Journal of Instrumentation 17, P05042 (2022)

13. P. Scherkl, et al., "Plasma photonic spatiotemporal synchronization of relativistic electron and laser beams", Physical Review Accelerators and Beams 25, 052803 (2022)

14. P. San Miguel Claveria, et al., "Spatiotemporal dynamics of ultrarelativistic beam-plasma instabilities", Physical Review Research 4, 023085 (2022)

15. D. Ullmann, et al., "All-optical density downramp injection in electron-driven plasma wakefield accelerators", Physical Review Research 3, 043163 (2021)

16. K. Hunt-Stone, R. Ariniello, C. E. Doss, J. R. Cary, and M. D. Litos, "Electro-optic sampling beam position monitor for relativistic electron beams", Nuclear Instruments and Methods in Physics Research, A 999, 165210 (2021)

17. A. Sampath, et al., "Extremely Dense Gamma-Ray Pulses in Electron Beam-Multifoil Collisions", Physical Review Letters 126, 064801 (2021)

18. R. Zgadzaj, et al., "Dissipation of electron-beam-driven plasma wakes", Nature Communications 11, 4753 (2020)

19. ALEGRO Collaboration, "Towards an Advanced Linear International Collider", arXiv:1901.10370v2 (2019)

20. C. Doss, et al., "Laser-ionized, beam-driven, underdense, passive thin plasma lens", Physical Review Accelerators and Beams 22, 111001 (2019)

21. A. Deng, O. Karger, et al., "Generation and acceleration of electron bunches from a plasma photocathode", Nature Physics 1745-2481 (2019)

22. M. Litos, R. Ariniello, C. Doss, K. Hunt-Stone, and J. R. Cary, "Beam emittance preservation using Gaussian density ramps in a beam-driven plasma wakefield accelerator", Philosophical Transactions of the Royal Society A 377, 20180181 (2019)

23. R. Ariniello, C. Doss, K. Hunt-Stone, J. R. Cary, and M. Litos, "Transverse beam dynamics in a plasma density ramp", Physical Review Accelerators and Beams 22, 041304 (2019)

24. M. Litos, R. Ariniello, C. Doss, K. Hunt-Stone, and J. R. Cary, "Experimental Opportunities for the Ion Channel Laser", Proceedings of the 2018 IEEE Advanced Accelerator Concepts Workshop (2018)

25. C. Lindstrom, et al., "Measurements of transverse wakefields induced by a misaligned positron bunch in a hollow channel plasma wakefield accelerator", Physical Review Letters 120, 124802 (2018)

26. C. Joshi, et al. "Plasma wakefield acceleration experiments at FACET-II", Plasma Physics and Controlled Fusion 60, 034001 (2018)

27. A. Doche, et al., "Acceleration of a trailing positron bunch in a plasma wakefield accelerator", Scientific Reports 7, 14180 (2017)

28. N. Vafaei-Najafabadi, et al., "Limitation on the accelerating gradient of a wakefield excited by an ultrarelativistic electron beam in rubidium plasma", Physical Review Special Topics: Accelerators and Beams 1212, 030004 (2017)

29. M. Litos and C. Jing, "Summary report of working group 4: Beam-driven acceleration", Proceedings of the 17th Advanced Accelerator Concepts Workshop (2017)

30. E. Adli, et al., "Long-range attraction of an ultrarelativistic electron beam by a column of neutral plasma", New Journal of Physics 18, 103013 (2016)

31. C. Clayton, et al., "Self-mapping the longitudinal field structure of a nonlinear plasma accelerator cavity", Nature Communications 7, 12483 (2016)

32. S. Corde, et al., "High-field plasma acceleration in a high-ionization potential gas", Nature Communications 7, 11898 (2016)

33. S. Gessner, et al., "Demonstration of a positron beam-driven hollow channel plasma wakefield accelerator", Nature Communications 7, 11785 (2016)