

Brian H. Clowers, Ph.D.

Associate Professor of Chemistry

Washington State University • Pullman, WA 99164
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Education

Post-Doctoral Research Scientist 2006-2008

Biological Separations and Mass Spectrometry
Fundamental Science Directorate
Pacific Northwest National Laboratory
Advisor: Dr. Richard D. Smith

Post-Doctoral Research Fellow 2005-2006

Department of Chemistry
University of California, Davis
Advisors: Drs. Carlito B. Lebrilla & Jerry L. Hedrick

Doctor of Philosophy, Chemistry 2005

Washington State University, Pullman, WA
Field of Specialty: Analytical Chemistry
Dissertation Title: *Separation of Gas Phase Isomers Using Ion Mobility and Mass Spectrometry*
Advisor: Prof. Herbert H. Hill

Bachelors of Science, Chemistry (ACS Certified) 2000

University of Nevada, Reno, NV
Thesis Title: *Characterization of Diesel Particulate Exposure Levels Experienced by Underground Mine Workers*
Advisor: Prof. Kent Ervin

Professional Experience

Visiting Professor (WSU Sabbatical) 2022-Present

Laboratory of Molecular Physical Chemistry
École Polytechnique Fédérale de Lausanne (Écublens, Switzerland)

Associate Professor 2018-Present

Department of Chemistry
Washington State University

Assistant Professor Department of Chemistry Washington State University	2013-2018
WSU-PNNL Joint Appointment National Security Directorate	2013-Present
Research Scientist Chemical and Biological Sciences National Security Directorate Pacific Northwest National Laboratory	2008-2013

Research and Scholarly Interests

Broadly, the Clowers Research Group focuses on the fundamentals, development, and application of rapid-gas-phase separation techniques with an emphasis on ion mobility and mass spectrometry. Key application areas include security screening (e.g. narcotics and explosives), real-time diagnostics for volatile organic compounds (VOC), and multidimensional assessment tools for health and biological systems evaluation. Deployed ion mobility instrumentation leverages well-established gas-phase ion chemistry, however, the existing modes of instrumental operation largely ignore recent advances in detector technologies, signal processing, and ion manipulation strategies. Notable advances pioneered by the Clowers Research Group continue to gain traction and adoption by instrument vendors with concurrent research collaborations with industry and a recently funded NIH R01 aimed at technology development and deployment. Additional, externally funded research efforts include approaches to probe VOC clustering dynamics in an effort to enhance detection limits (NSF) and high resolution mass spectrometry technologies aimed at quantifying environmental stress at the protein level in fungal and plant systems (Department of Defense).

Awards and Recognition

Boeing Distinguished Professor of STEM Education (2020-Present)

Graduate Chemistry Instructor of the Year: 2018

WSU Provost Leadership Academy (2018-2019)

Outstanding Peer-Reviewer (2018)

- Journal for the American Society for Mass Spectrometry

Emerging Investigator (2017)

- American Society for Mass Spectrometry

Award for Early Career Achievement (2015)

- WSU College of Arts and Sciences

Outstanding Performance Award (2009)

- National Security Directorate, Pacific Northwest National Laboratory

Post-Doctoral Fellowship (2005-2006)

- NIH Fertilization and Early Development Training Grant

NSF Graduate Fellowship (2001-2005)

- NSF IGERT Program

Professional Affiliations

American Society for Mass Spectrometry

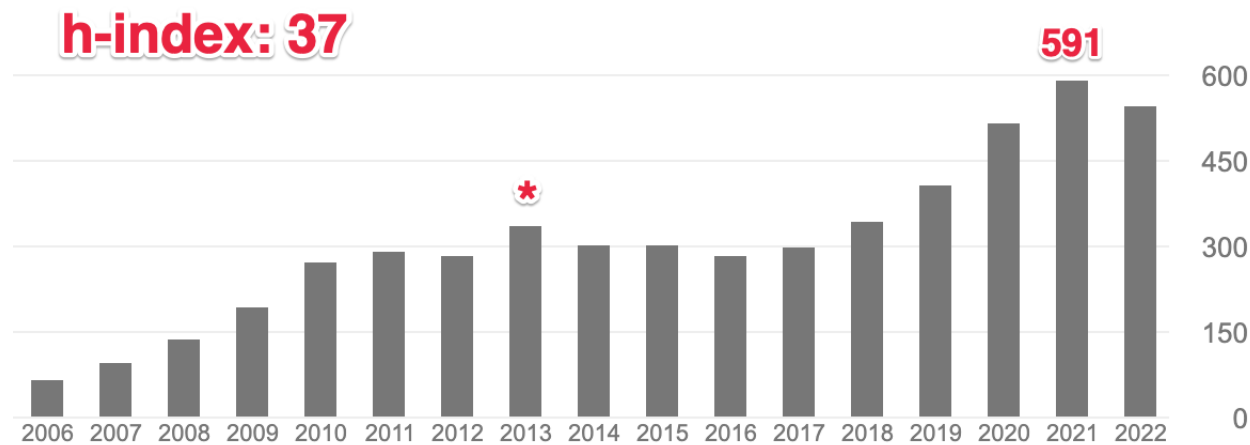
International Society for Ion Mobility Spectrometry

American Chemical Society

-Analytical Chemistry Division

Peer-Reviewed Publications

As of November 21, 2022 the following publications have yielded over 5300 citations with an h-index of 37. For the listed publications below, citations above #44 represent works attributed to efforts while at WSU. (IF = Impact Factor)



Source: <https://scholar.google.com/citations?user=AugbEVsAAAAJ&hl=en> updated Nov. 21, 2022.

*Denotes the start of the tenure-track position at WSU.

*Graduate Student

†Undergraduate

‡Post-Doctoral Researcher

103. Cabrera, E.R.* and Clowers, B.H. Considerations for Generating Frequency Modulation Waveforms for Fourier Transform-Ion Mobility Experiments. 2022. *Journal of the American Society for Mass Spectrometry*, 33(10), pp.1858-1864.(IF = 3.0)

102. Schramm, H.M.*, Tamadate, T.,‡ Hogan, H. J., Clowers, B.H. Ion-Neutral Clustering Alters Gas-Phase Hydrogen-Deuterium Exchange Rates. Under Review at *Angew Chem Int Ed Engl.* (IF = 15.3)

101. Reinecke, T.,‡ Kenyon, S., Gendreau, K., Clowers, B.H. Characterization of a Modulated X-ray Source for Ion Mobility Spectrometry. *Analytical Chemistry*, 94(35), pp.12008-12015.(IF = 6.9)

100. Sipe, S.,* Sanders, J.,* Reinecke, T.,‡ Clowers, B. H., Brodbelt, J. Separation and Collision Cross Section Measurements of Protein Complexes Afforded by a Modular Drift Tube Coupled to an Orbitrap Mass Spectrometer. *Analytical Chemistry*, Accepted, 06/05/2022. (IF = 6.9)
99. Kinlein, Z.R.,* Anderson, G.A. and Clowers, B.H., 2022. Accelerating prototyping experiments for traveling wave structures for lossless ion manipulations. *Talanta*, 244, p.123446. (<https://doi.org/10.1016/j.talanta.2022.123446>) (IF = 6.0)
98. Lee, J.,* Clowers, B.H. and Hogan, C.J., 2022. Condensable Vapor Sorption by Low Charge State Protein Ions. *Analytical Chemistry*. (<https://doi.org/10.1021/acs.analchem.2c00357>) (IF = 6.9)
97. Cabrera, E.R.* and Clowers, B.H., 2022. Synchronized Stepped Frequency Modulation for Multiplexed Ion Mobility Measurements. *Journal of the American Society for Mass Spectrometry*, 33(3), pp.557-564. (<https://doi.org/10.1021/jasms.1c00365>) (IF = 3.2)
96. McKenna, K.R.,* Clowers, B.H., Krishnamurthy,* R., Liotta, C.L. and Fernández, F.M., 2021. Separations of Carbohydrates with Noncovalent Shift Reagents by Frequency-Modulated Ion Mobility-Orbitrap Mass Spectrometry. *Journal of the American Society for Mass Spectrometry*. (<https://pubs.acs.org/doi/10.1021/jasms.1c00184>) (IF = 3.2)
95. Naylor, C.N.,* Reinecke, T.,‡ Ridgeway, M.E., Park, M.A. and Clowers, B.H., 2021. Implications of Blanc's Law for Use in Trapped Ion Mobility Spectrometry. *Journal of the American Society for Mass Spectrometry*. (<https://doi.org/10.1021/jasms.1c00168>) (IF = 3.2)
94. Sanders, J.D.,* Butalewicz, J.P.,* Clowers, B.H. and Brodbelt, J.S., 2021. Absorption Mode Fourier Transform Ion Mobility Mass Spectrometry Multiplexing Combined with Half-Window Apodization Windows Improves Resolution and Shortens Acquisition Times. *Analytical Chemistry*, 93(27), pp.9513-9520. (<https://doi.org/10.1021/acs.analchem.1c01427>) (IF = 6.8)

93. Clowers, B.H., Cabrera, E.,* Anderson, G., Deng, L., Moser, K., Van Aken, G. and DeBord, J.D., 2021. Masked Multiplexed Separations to Enhance Duty Cycle for Structures for Lossless Ion Manipulations. *Analytical chemistry*, 93(14), pp.5727-5734. (<https://doi.org/10.1021/acs.analchem.0c04799>) (IF = 6.8)
92. Ligare, M.R., Morrison, K.A.,* Hewitt, M.A., Reveles, J.U., Govind, N., Hernandez, H., Baker, E.S., Clowers, B.H., Laskin, J. and Johnson, G.E., 2021. Ion Mobility Spectrometry Characterization of the Intermediate Hydrogen-Containing Gold Cluster Au₇ (PPh₃)₇H₅₂⁺. *The Journal of Physical Chemistry Letters*, 12(10), pp.2502-2508. (<https://doi.org/10.1021/acs.jpcllett.0c03664>) (IF = 7.3)
91. Davis, E.J., Walker, D.,† Gibney,† M. and Clowers, B.H., Optical and mass spectral characterization of the electrospray ionization/corona discharge ionization interface. *Talanta*, 224, p.121870. (2021) (<https://doi.org/10.1016/j.talanta.2020.121870>) (IF = 5.4)
90. Naylor, C.N.* and Clowers, B.H., 2021. Reevaluating the Role of Polarizability in Ion Mobility Spectrometry. *Journal of the American Society for Mass Spectrometry*. (2021) (<https://doi.org/10.1021/jasms.0c00338>) (IF = 3.2).
89. Kwantwi-Barima, P.,* Reinecke, T.,‡ Clowers, B.H. Enabling resolution of isomeric peptides using tri-state ion gating and Fourier-transform ion mobility spectrometry. *International Journal for Ion Mobility Spectrometry* 23, 133-142. (2020) (<https://doi.org/10.1007/s12127-020-00261-4>) (IF = 2.1)
88. Kwantwi-Barima, P.,* Hogan Jr, C.J. and Clowers, B.H., 2020. Probing Gas-Phase-Clustering Thermodynamics with Ion Mobility-Mass Spectrometry: Association Energies of Phenylalanine Ions with Gas-Phase Alcohols. *Journal of the American Society for Mass Spectrometry*, 31(9), pp.1803-1814. (2020) (<https://doi.org/10.1021/jasms.0c00020>) (IF = 3.2)
87. Naylor, C.N.,* Ridgeway, M.E., Park, M.A. and Clowers, B.H., 2020. Evaluation of Trapped Ion Mobility Spectrometry (TIMS) Source Conditions Using Benzylammonium Thermometer Ions. *Journal of the American Society for Mass Spectrometry*. 31, 7, 1593–1602. (2020) (<https://doi.org/10.1021/jasms.0c00151>) (IF = 3.2)

86. Naylor, C.N.,* Reinecke, T.,‡ Clowers, B.H.: Assessing the Impact of Drift Gas Polarizability in Polyatomic Ion Mobility Experiments. *Analytical Chem.* (2020) (<https://doi.org/10.1021/acs.analchem.9b04468>) (IF = 6.4)
85. Freels, T.G., Baxter-Potter, L.N., Lugo, J.M., Glodosky, N.C., Wright, H.R., Baglot, S.L., Petrie, G.N., Yu, Z.,* Clowers, B.H., Cuttler, C., et al.: Vaporized cannabis extracts have reinforcing properties and support conditioned drug-seeking behavior in rats. *Journal of Neuroscience.* (2020) (<https://doi.org/10.1523/jneurosci.2416-19.2020>) (IF = 6.1)
84. Reinecke, T.,‡ Naylor, C.N.,* Clowers, B.H.: Ion multiplexing: Maximizing throughput and signal to noise ratio for ion mobility spectrometry. *Trends Analytical Chem.* (2019) (IF = 8.4)
83. Kwantwi-Barima,* P., Reinecke, T.,‡ Clowers, B.H.: Increased ion throughput using tristate ion-gate multiplexing. *Analyst.* 144, 6660–6670 (2019) (IF = 3.9)
82. Morrison, K.A.,* Clowers, B.H.: Fundamentals and applications of incorporating chromatographic separations with ion mobility-mass spectrometry. *Trends Analytical Chem.* 115625 (2019) (IF = 8.4)
81. Naylor, C.N.,* Reinecke, T.,‡ Ridgeway, M.E., Park, M.A., Clowers, B.H.: Validation of Calibration Parameters for Trapped Ion Mobility Spectrometry. *J. Am. Soc. Mass Spectrom.* 30, 2152–2162 (2019) (IF = 3.2)
80. Craft, R.M., Britch, S.C., Buzitis, N.W.* and Clowers, B.H., Age-related differences in Δ^9 -tetrahydrocannabinol-induced antinociception in female and male rats. *Experimental and clinical psychopharmacology.* Mar 2019. (<https://doi.org/10.1037/pha0000257>)
79. Reinecke, T.,‡ Davis, A.L.,* Clowers, B.H. Determination of Gas-Phase Ion Mobility Coefficients using Voltage Sweep Multiplexing. *Journal of the American Society for Mass Spectrometry.* Jan 2019. (<https://doi.org/10.1007/s13361-019-02182-x>) (IF = 3.2)
78. Kwantwi-Barima, P.,* Hogan, C.J. Jr., Clowers, B.H. Deducing Proton-Bound Heterodimer Association Energies from Shifts in Ion Mobility Arrival Time Distributions. *J. Phys Chem A.* 123 (13), 2957-2965, 2019. (<https://doi.org/10.1021/acs.jpca.8b11183>) (IF = 2.8)

77. Davis, A. L.*; Reineke, T.,‡ Morrison, Kelsey A.*; Clowers, Brian H. Optimized Reconstruction Techniques for Multiplexed Dual-Gate Ion Mobility Mass Spectrometry Experiments. *Analytical Chemistry*, 91(2), 1432-1440, 2018. (IF = 6.4)
76. Morrison, K. A.*; Bythell, B.J.; Clowers, B. H. Interrogating Gas-Phase Clustering of Organophosphonate Species via Atmospheric Flow Tube-Mass Spectrometry. *Journal of the American Society for Mass Spectrometry*, 20 (7), 1308-1320, 2019. (IF = 3.2)
75. Morrison, K. A.,* Ewing, R. G., Clowers, B. H. Ambient Vapor Sampling and Selective Cluster Formation for the Trace Detection of Tributyl Phosphate via Atmospheric Flow Tube Mass Spectrometry. *Talanta*, 195, 683-690, 2019. (IF = 4.9)
74. Morrison, K. A.,* Bendiak, B. K., Clowers, B. H. Assessment of Dimeric Metal-Glycan Adducts via Isotopic Labeling and Ion Mobility-Mass Spectrometry. *J. Am. Soc. Mass Spectrom.* 2018, 29 (8), 1638-1649. (IF = 3.2)
73. Morrison, K. A.* and Clowers, B. H. Characterization of Phosphonic Acid Vapors Using Atmospheric Flow Tube-Ion Trap Mass Spectrometry. *Rapid Comm. Mass Spectrom.* 2018, 32 (16), 1363-1371.
72. Opačić, B., Huntley, A.P., Clowers, B.H. and Reilly, P.T.A., 2018. Digital Mass Filter Analysis in Stability Zones A and B. *Journal of mass spectrometry*. (<https://doi.org/10.1002/jms.4295>) (IF = 1.9)
71. Yu, Z.,* Huang, M. and Clowers, B.H., 2018. Comparative metabolite profiling of a metastatic and primary melanoma cell line using untargeted metabolomics: A case study. *Clinical Mass Spectrometry*, 10, pp.16-24.
70. Yu, Z.,* Miller, H.C., Puzon, G.J. and Clowers, B.H., 2018. Application of untargeted metabolomics for the detection of pathogenic *Naegleria fowleri* in an operational drinking water distribution system. *Water Research*, 145, pp.678-686.
69. Gabelica, V., Shvartsburg, A.A., Afonso, C., Barran, P., Benesch, J.L.P., Bleiholder, C., Bowers, M.T., Bilbao, A., Bush, M.F., Campbell, J.L., Others: Recommendations for

- reporting ion mobility Mass Spectrometry measurements. *Mass Spectrom. Rev.* 38, 291–320 (2019) (IF = 9.4)
68. Greene, N.Z., Wiley, J.L., Yu, Z.,* Clowers, B.H. and Craft, R.M., 2018. Cannabidiol modulation of antinociceptive tolerance to Δ 9-tetrahydrocannabinol. *Psychopharmacology*, 235(11), pp.3289-3302.
67. Reinecke, T.‡ and Clowers, B.H., 2018. Implementation of a flexible, open-source platform for ion mobility spectrometry. *HardwareX*, 4. (<https://doi.org/10.1016/j.ohx.2018.e00030>) (IF = 3.0)
66. Opačić, B.,* Hoffman, N.M.,* Clowers, B.H. and Reilly, P.T., 2018. Impact of injection potential on measured ion response for digitally driven mass filters. *International Journal of Mass Spectrometry*, 434, pp.1-6.
65. Opačić, B.,* Hoffman, N.M.,* Gotlib, Z.P.,* Clowers, B.H. and Reilly, P.T., 2018. Using digital waveforms to mitigate solvent clustering during mass filter analysis of proteins. *Journal of The American Society for Mass Spectrometry*, 29(10), pp.2081-2085.
64. Hoffman NM,* Gotlib ZP,* Opačić B, Clowers BH, Reilly PT. A comparison based digital waveform generator for high resolution duty cycle. *Review of Scientific Instruments*. 2018 Aug 1;89(8):084101.
63. Poltash ML, McCabe JW, Shirzadeh M, Laganowsky A, Clowers BH, Russell DH. Fourier Transform-Ion Mobility-Orbitrap Mass Spectrometer: A Next-Generation Instrument for Native Mass Spectrometry. *Analytical Chemistry*. 2018 Aug 9;90(17):10472-8. (<https://doi.org/10.1021/acs.analchem.8b02463>) (IF = 6.9)
62. Morrison, K.A. * and Clowers, B.H., Contemporary glycomic approaches using ion mobility–mass spectrometry. *Current Opinion in Chemical Biology*, 2018, 42, 119-129. (IF = 7.9)
Role: Clowers contributed significantly to the manuscript including the selection of figures and relevant topics discussed in this invited review article.

61. Davis, A.L.,* Clowers, B.H., Stabilization of Gas-Phase Uranyl Complexes Enables Rapid Speciation using Electrospray Ionization and Ion Mobility-Mass Spectrometry. *Talanta* 2018, 176, 140-150. (IF = 3.5)
Role: Clowers identified the potential utility of sulfoxides to stabilize the gas-phase complexes of f-elements and provided intensive guidance on manuscript preparation.
60. Davis, A.L.,* Clowers, B.H., Leveraging Spectral Sparsity to Realize Enhanced Separation of Gas-Phase Ion Populations Utilizing I_1 Minimization. *International Journal of Mass Spectrometry*. 2018, 20 (3-4), 87-93 (IF = 2.1)
Role: Clowers developed the hardware, computer code for the initial pulsing sequences, and provided intellectual guidance in manuscript development.
59. Garcia, L.,† Saba, C. †, Manocchio, G.,† Anderson, G.A., Davis, E. and Clowers, B.H., An open source ion gate pulser for ion mobility spectrometry. *International Journal for Ion Mobility Spectrometry*, 2017 20(3-4), pp.87-93. (IF = 0.6)
Role: The undergraduate group visiting as part of NSF-funded program conducted the experiments with Clowers designing the experiments, providing technical guidance, and manuscript editing.
58. Kwantwi-Barima, P.*, Ouyang, Hogan, C. J., Clowers, B. H. Tuning Mobility Separation Factors of Chemical Warfare Agent Degradation Products via Selective Ion-Neutral Clustering. *Analytical Chemistry*, 2017, 89 (22), 12416-12424. *Analytical Chemistry*. (IF = 5.6)
Role: Clowers devised the range of experimental variable and conditions to be probed. Additionally, Clowers devised the underlying data processing scripts used in the analysis campaign.
57. Keelor, J.D., * Zambrzycki, S.,* Li, A.,* Clowers, B.H., and Fernández, F.M. Atmospheric Pressure Drift Tube Ion Mobility-Orbitrap Mass Spectrometry: Initial Performance Characterization. *Analytical Chemistry*. 2017, 89 (21), 11301-11309 2017. (IF = 5.6)
Role: Clowers supplied experimental guidance and operational insight into this class of chemical instrumentation.

56. Liu, W., Davis, A.L.,* Siems, W.F., Yin, D., Clowers, B.H. and Hill Jr, H.H., 2017. Ambient pressure inverse ion mobility spectrometry coupled to mass spectrometry. *Analytical Chemistry*, 2017, 89(5), pp.2800-2806. (IF = 5.6)
Role: Clowers devised the initial ion gate pulsing schemes and was primarily responsible for the manuscript revision and figure assembly.
55. Britch, S. C.,* Wiley, J. L.,* Yu, Z., * Clowers, B. H., Craft, R. M.
 Cannabidiol- Δ^9 -Tetrahydrocannabinol Interactions on Acute Pain and Locomotor Activity. *Drug and Alcohol Dependence*. 2017, 175, 187-197. (IF = 3.3)
Role: Clowers devised the experimental approach and parameters for analysis using liquid chromatography and mass spectrometry.
54. Yu, Z.,* Miller, H. C., Puzon, G. J., Clowers, B. H. Development of Untargeted Metabolomics Methods for the Rapid Detection of Pathogenic *Naegleria fowleri*. *Environ. Sci. Technol.* 2017, 51 (8), 4210-4219. (IF=5.33)
Role: Clowers aided significantly in the construction of the manuscript along with the initial data analysis workflows used in the analysis. Clowers also oversaw the chromatographic and mass spectrometry method development.
53. Morrison, K. A.,* Clowers, B. H. Differential Fragmentation of Mobility-Selected Glycans via Ultraviolet Photodissociation and Ion Mobility-Mass Spectrometry. *Journal of the American Society for Mass Spectrometry*. 2017 28(6):1236-1241. doi: 10.1007/s13361-017. (IF=2.95)
Role: Clowers constructed the optical-vacuum interface and conducted the initial experiments regarding the modes of fragmentation. Clowers also provided the initial experimental outline and the initial figures for publication.
52. Davis, A.L., Liu, W., Siems, W.F. and Clowers, B.H., Correlation ion mobility spectrometry. *Analyst*. 2017, 142, 292-301 (IF = 4.1)
Role: Clowers developed the pulsing hardware, initial code for generating pulse sequences, the broad experimental outline and direct editorial feedback during manuscript construction.
51. Craft, R.M., Haas, A.E., Wiley, J.L., Yu, Z.,* Clowers, B.H. Gonadal hormone modulation of Δ^9 -tetrahydrocannabinol-induced antinociception and metabolism in female versus male

rats, *Pharmacology Biochemistry and Behavior*, 2016, doi: 10.1016/j.pbb.2016.09.006. (IF = 2.8)

Role: Clowers devised the experimental approach and parameters for analysis using liquid chromatography and mass spectrometry.

50. Choy, C.J., Ley, C.R., Davis, A.L., Backer, B.S., Geruntho, J.J., Clowers, B.H., Berkman, C.E. Second-Generation Tunable pH-Sensitive Phosphoramidate-Based Linkers for Controlled Release. *Bioconjugate Chemistry*. 2016 Sep 2;27(9):2206-13. (IF = 4.5)

Role: Clowers directed A.L. Davis in the development of a chromatographic method and aided in the analysis protocol used for data interpretation.

49. Morrison, K. A.,* Bendiak, B.K., Clowers, B.H. Enhanced Mixture Separations of Metal Adducted Tetrasaccharides Using Frequency Encoded Ion Mobility Separations and Tandem Mass Spectrometry. *Journal of the American Society for Mass Spectrometry* (2016): 1-14. (IF = 2.9)

Role: Clowers aided in the development of the experimental plan and broad parameters for manipulation. Additional contributions included data analysis, collaborative figure generation, and manuscript editing.

48. Morrison, K A.*, Siems, W.F., Clowers, B.H. Augmenting Ion Trap Mass Spectrometers Using Drift Tube Ion Mobility and the Fourier Transform. *Analytical Chemistry* 2016, 88 (6), pp 3121–3129. (<https://doi.org/10.1021/acs.analchem.5b04223>) (IF = 5.6)

Role: Clowers formulated the experimental plan, hardware configurations, analysis scripts, and provided support and guidance regarding project management, manuscript construction, and figure development.

47. Leiser, O. P.; Merkley, E. D.; Clowers, B. H.; Deatherage Kaiser, B. L.; Lin, A.; Hutchison, J. R.; Melville, A. M.; Wagner, D. M.; Keim, P. S.; Foster, J. T.; et al. Investigation of *Yersinia pestis* Laboratory Adaptation through a Combined Genomics and Proteomics Approach. *PLoS ONE* 2015, 10 (11), e0142997 DOI: 10.1371/journal.pone.0142997. (IF = 3.2)

Role: Clowers developed the statistically-based experimental design, instrumental method of analysis, and collected the bulk of the proteomics data outlined in this manuscript.

46. Clowers, B. H.; Siems, W. F.; Yu, Z.*; Davis, A. L.* A two-phase approach to Fourier transform ion mobility time-of-flight mass spectrometry. *Analyst* 2015, 140 (20), 6862–6870. (IF = 4.1)
Role: Combined with Dr. Siems, Clowers developed the original concept underpinning this work. The raw pulsing sequences, pulsing hardware, and the bulk of data collection were performed by Clowers. Following the development of the analysis scripts the students Yu and Davis provided support regarding data processing, figure development, and in select cases data collection.
45. Andy Lin, A., Merkley, E.D., Clowers, B.H., Hutchison, J.R., Kreuzer, H.K. Effects of Bacterial Inactivation Methods on Downstream Proteomic Analysis. *Journal of Microbiological Methods*. 2015, 112, 3–10. (IF = 2.0)
Role: In addition to furnishing the initial analysis scripts for this work, Clowers developed the analytical methodology and collected all of the data used in this work.
44. Prost, S. A., Crowell, K. L., Baker, E. S., Ibrahim, Y. M., Clowers, B. H., Monroe, M. E., Anderson, G.A., Smith, R.D., Payne, S. Detecting and Removing Data Artifacts in Hadamard Transform Ion Mobility-Mass Spectrometry Measurements. *Journal of the American Society for Mass Spectrometry*, 2014, 1-8. (IF = 2.9)
Role: Clowers provided the initial pulse sequences used for the experiments along with key algorithmic insights for post-processing analysis of multiplexed data.
43. Webb-Robertson, B.J.M., Corley, C.D., McCue, L.A., Clowers, B.H., Dowling, C.P. Forensic Signature Detection of *Yersinia pestis* Culturing Practices across Institutions Using a Bayesian Network. *J Forensic Investigation*, 2014. 2(1), 7. (IF = 1.25)
Role: This work details a post-hoc analysis of experiments and data acquired by Clowers. Additionally, Clowers distilled the raw data into the formats necessary for comparisons.
42. Wunschel, D.S., E. Tulman, H. Engelmann, B.H. Clowers, S. Geary, A. Robinson,† L. Xiaofen. Forensic proteomics of poxvirus production. *Analyst*. 2013: 138(21) p. 6385-6397. (IF = 4.1)
Role: Clowers provided detailed oversight for the sample and data analysis pipelines including data interpretation.

41. Wunschel, D.S., H. Engelmann, K. Victry, B.H. Clowers, C. Sorensen, N.B. Valentine, C. Mahoney, Christine, T. Wietsma, K.L. Wahl. Protein markers for identification of *Yersinia pestis* and their variation related to culture. *Molecular and Cellular Probes*. 2014. 28(2-3): p. 65-72
Role: Clowers provided detailed oversight for the sample and data analysis pipelines including data interpretation.
40. Ewing, R.G., B.H. Clowers, D.A. Atkinson. Direct Real-Time Detection of Vapors from Explosive Compounds. *Analytical Chemistry*. 2013. 85(22): p. 10977-10983.
39. Clowers, B.H., D.S. Wunschel, H.E. Kreuzer, H. Engelmann, N.B. Valentine, K.L. Wahl. Characterization of Residual Medium Peptides from *Yersinia pestis* Cultures. *Analytical Chemistry*. 2013. 85(8): p. 3933-3939.
38. Robert Ewing, David A. Atkinson, Brian H. Clowers. Direct Real-Time Detection of RDX Vapors Under Ambient Conditions. *Analytical Chemistry*. 2013. 85(1); p. 389-397.
37. Davis, E.J., B.H. Clowers, W.F. Siems, H.H. Hill. Comprehensive software suite for the operation, maintenance, and evaluation of an ion mobility spectrometer. *International Journal for Ion Mobility Spectrometry*. 2011, 14(2-3): p. 117-124.
36. Froehlich, J.W., M. Barboza, C. Chu, L.A. Lerno, B.H. Clowers, A.M. Zivkovic, J.B. German, and C.B. Lebrilla. Nano-LC-MS/MS of Glycopeptides Produced by Nonspecific Proteolysis Enables Rapid and Extensive Site-Specific Glycosylation Determination. *Analytical Chemistry*, 2011. 83(14): p. 5541-5547.
35. Shah, A.R., J. Davidson, M.E. Monroe, A.M. Mayampurath, W.F. Danielson, Y. Shi, A.C. Robinson, B.H. Clowers, M.E. Belov, G.A. Anderson, and R.D. Smith. An Efficient Data Format for Mass Spectrometry-Based Proteomics. *Journal of the American Society for Mass Spectrometry*, 2010. 21(10): p. 1784-1788.
34. Fraga, C.G., B.H. Clowers, R.J. Moore, and E.M. Zink. Signature-Discovery Approach for Sample Matching of a Nerve-Agent Precursor Using Liquid Chromatography-Mass Spectrometry, XCMS, and Chemometrics. *Analytical Chemistry*, 2010. 82(10): p. 4165-4173.

33. Zhu, M.L., B. Bendiak, B.H. Clowers, and H.H. Hill. Ion mobility-mass spectrometry analysis of isomeric carbohydrate precursor ions. *Analytical and Bioanalytical Chemistry*, 2009. 394(7): p. 1853-1867.
32. Tolmachev, A.V., B.H. Clowers, M.E. Belov, and R.D. Smith. Coulombic Effects in Ion Mobility Spectrometry. *Analytical Chemistry*, 2009. 81(12): p. 4778-4787.
31. Johnson, T.J., Y.F. Su, N.B. Valentine, H.W. Kreuzer-Martin, K.L. Wahl, S.D. Williams, B.H. Clowers, and D.S. Wunschel. The Infrared Spectra of Bacillus Bacteria Part I: Vegetative Bacillus versus Sporulated Cells and the Contributions of Phospholipids to Vegetative Infrared Spectra. *Applied Spectroscopy*, 2009. 63(8): p. 899-907.
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Book Chapters

1. Wahl, Karen L., Wunschel, David S. and Clowers, Brian H. 2010. "Proteomics Development and Application for Bioforensics." Chapter 26 in *Microbial Forensics, 2nd Edition*, ed. B Budowle, SE Schutzer, RG Breeze, PS Keim and SA Morse, pp. 449-460. Academic Press/Elsevier, Burlington, MA.

Patents/Invention Disclosures

Items numbered in bold represent work completed while at WSU.

*Denotes graduate student contributions.

- 8.** Signal Modulation for Encoding Information in Multiple Dimensions. Clowers. B.H., Cabrera, E.R.,* Laganowsky, A., Russell, D. H. Washington State University and Texas A&M University, 2021 U.S. Provisional Patent 3462.
- 7.** Destruction of Nucleic Acid Chains from Collected Biological Material. Clowers. B.H., Hill, H.H., Lovrich, N., Nosbusch, P.* Washington State University, 2017. U.S. Provisional Patent 1756.
- 6.** A Device for the Generation of Digital Waveforms with High Resolution Duty Cycle for Creating Digital Waveform Driven Mass Filters. Reilly, P.T.A., Clowers. B.H., Gotlib, Z.,* Hoffman, N.M.,* Washington State University, 2017. U.S. Provisional Patent 1792.
- 5.** Particle-based drug detection methods. Hill Jr, H.H., Clowers, B. and Lovrich, N., Washington State University, 2016. U.S. Patent Application 15/217,856.
- 4.** Method for selective detection of explosives in mass spectrometer or ion mobility spectrometer at parts-per-quadrillion level. US9123520B2, 2015.
- 3.** System and process for selective detection of vapor-phase analytes. US Pat. 20130260478, 2013.
- 2.** Ion funnel ion trap and process. US Pat. 12156360, 2010
 - *Licensed by Agilent Technologies 2011*
- 1.** Mass analysis of mobility selected ion populations US Pat. 11582198, 2007
 - *Licensed by ExellIMS from WSU in 2013*

Invited and Contributed Oral Presentations

Works numbered in bold represent presentations while WSU faculty. Below is a non-comprehensive list of recent oral presentations to the relevant research communities.

*Graduate student contributions

51. *Construction and Evaluation of Two Open-Source, Low-Pressure Ion Mobility Drift Cells Coupled with Ion Trap Mass Analyzers.* Nathan W. Buzitis,* James Sanders, Jennifer S Brodbelt, Brian H. Clowers. Annual Conference for the American Society for Mass Spectrometry. June 9, 2022. Minneapolis, MN
50. *Minimizing Measurement Times in Fourier Transform Ion Mobility Experiments Using Non-Linear Frequency Modulation.* Elvin R. Cabrera* and Brian H. Clowers. Annual Conference for the American Society for Mass Spectrometry. June 6, 2022. Minneapolis, MN
49. *Correlating Peptide Charge State with Gas-Phase Hydrogen/Deuterium Exchange Rates and Vapor-induced Arrival Time Shifts.* Haley M. Schramm,* Christopher J. Hogan, Brian H. Clowers. Annual Conference for the American Society for Mass Spectrometry. June 6, 2022. Minneapolis, MN
48. *Simultaneous Measurement of Gas-Phase Hydrogen/Deuterium Exchange Rates and Ion/Neutral Clustering using Ion Mobility-Mass Spectrometry.* Haley M. Schramm,* Christopher J. Hogan, Brian H. Clowers. Annual Conference for the American Society for Mass Spectrometry. November 4, 2021. Philadelphia, PA.
47. *Enhancing TW-SLIM Flexibility using a Multifunctional Traveling Wave Generator.* Zackary Kinlein,* Gordon Anderson, Brian Clowers. Conference for the International Society for Ion Mobility Spectrometry, July 29th, 2021
46. *Next Generation Ion Manipulation Strategies for 'Omics Platforms*, Brian H. Clowers, Divisional Seminar, Chemistry, University of Wisconsin, Madison, February 17, 2021.
45. *Tractable Frameworks for Maximizing Ion Throughput Across Mass and Mobility Domains*, Brian H. Clowers, Departmental Seminar, Chemistry, Indiana University, November 11, 2019.
44. *Augmenting Gas-Phase Mobility Separation Factors Through Selective Ion-Neutral Clustering*, Brian H. Clowers, Departmental Seminar, Chemistry, Whitworth University, October 24, 2019

44. *Development of a Flexible, Non-Linear Ion Beam Modulation Strategy to Maximize Ion Throughput.* Tobias Reinecke, Pearl Kwantwi-Barima,* Brian H. Clowers. Annual Meeting for the International Society for Ion Mobility Spectrometry. Hannover, Germany, July, 25, 2019.
43. *Expanding the Utility of Ion Mobility Using Mixed Drift Gases.* Cameron Naylor* Tobias Reinecke, Brian H. Clowers. Annual Meeting for the International Society for Ion Mobility Spectrometry. Hannover, Germany, July, 25, 2019.
41. *Maximizing Signal to Noise Ratio for Voltage Sweep Multiplexing-Ion Mobility-Ion Trap Mass Spectrometry.* Tobias Reinecke, Pearl Kwantwi-Barima,* and Brian H. Clowers. Annual Conference for the American Society for Mass Spectrometry. June 5, 2019. Atlanta, GA.
42. *Ion Beam Modulation Strategies to Maximize Throughput for Ion Mobility Spectrometry.* Brian H. Clowers. Department of Chemistry, Departmental Seminar, Texas A&M University, May 17, 2019.
41. *Ion Beam Modulation Strategies to Maximize Throughput for Ion Mobility Spectrometry.* Brian H. Clowers. Department of Chemistry, Departmental Seminar, University of Texas, May 15, 2019.
40. *Augmenting the Classical Ion Mobility Experiment: Selective Vapor Clustering and the Role of Polarizability.* Brian H. Clowers. Department of Chemistry, Departmental Seminar, Florida International University, March 28, 2019
39. *Determination of Ion Mobilities in Complex Gas Mixtures: Evaluation of Blanc's Law for Polyatomic Ions,* Brian H. Clowers, Cameron Naylor,* Tobias Reinecke. Annual Spring American Chemical Society National Meeting 2019, March 31-April 4 2019, Orlando, FL.
38. *Enhancing Disaccharide Ion Mobility Separations Through Shift Reagents and Frequency Modulation.* Kristin R. McKenna, Li Li, Kelsey Morrison,* Brian H. Clowers, Facundo M. Fernandez. Annual Spring American Chemical Society National Meeting 2019, March 31-April 4 2019, Orlando, FL.
37. *Roadway and Workplace Cannabis Impairment: Progress to Date & Future Developments.* Nicholas Lovrich and Brian H. Clowers. Washington State Academy of Sciences Annual Meeting. TOPIC: The Highs and Lows of Conducting Research on Cannabis in Washington State. September 13, 2018.
36. *From Research to Reality: The Implementation of Ion Mobility Spectrometry.* Herbert H. Hill and Brian H. Clowers. Analytica 2018, Munich, Germany.

35. *Speeding Toward an Answer: Enhancing Dual-Gate IMS-Ion Trap Acquisition Rates*. Austen L. Davis, Tobias Reinecke, Kelsey Morrison,* Brian H. Clowers. Annual Meeting for the International Society for Ion Mobility Spectrometry 2018, July 22-27 2018, Calgary, AB. (Oral Presentation)
34. *Interrogating the Extensive Gas-Phase Clustering of Organophosphonate Species via Atmospheric Flow Tube-Mass Spectrometry*. Kelsey A. Morrison,* Brian H. Clowers. Annual Meeting for the International Society for Ion Mobility Spectrometry 2018, July 22-27 2018, Calgary, AB. (Oral Presentation)
33. *Chemical Warfare Agent Simulant Speciation and Detection via Atmospheric Flow Tube-Mass Spectrometry*. Kelsey A. Morrison,* Brian H. Clowers. Annual American Chemical Society Northwest Regional Meeting 2018, June 24-27 2018, Richland, WA. (Oral Presentation)
30. *Deducing Association Energies from Shifts in Arrival Time Distributions: Impacts Of Selective Gas-Phase Ion-Vapor Clustering*. Pearl Kwantwi-Barima, Christopher J. Hogan, Brian H. Clowers, Annual Meeting for the American Society for Mass Spectrometry Conference 2018. June 3-7, 2018, San Diego, CA. (Oral Presentation)
29. *Selective Gas-Phase Ion-Vapor Clustering To Enhance Ion Mobility Separation Factors: Deducing Association Energies*. Pearl Kwantwi-Barima, Christopher J. Hogan, Brian H. Clowers, Northwest Regional Meeting 2018. June 24-27, 2018, Richland, WA. (Oral Presentation)
28. *Selective Gas-Phase Clustering: Practical Applications of Cluster Thermodynamics*. Brian H. Clowers, January 30, 2018. Florida State University (Invited Departmental Seminar).
27. *Selective Gas-Phase Clustering: Practical Applications of Cluster Thermodynamics*. Brian H. Clowers, January 29, 2018. University of Florida (Invited Departmental Seminar).
26. *Maximizing Resolution and High Throughput: Compressive Sensing and Ion Multiplexing*. Brian H. Clowers and Austen L. Davis,* Annual Conference for the International Society for Ion Mobility Spectrometry. July 21-25 2017, Warsaw, Poland. (Oral Presentation)
26. *Transformational Approaches for Realizing High Resolution, High Throughput Ion Mobility Measurements: Compressive Sensing and Ion Multiplexing*. Austen L. Davis,* Brian H.

- Clowers, Annual Meeting for the American Society for Mass Spectrometry Conference 2017. June 4 -8 2017, Indianapolis, IN. (Oral Presentation)
25. *Tuning Gas-Phase Mobility Separation Factors via Selective Ion-Neutral Clustering*. Brian H. Clowers, May 1, 2017. University of Oregon (Invited Departmental Seminar).
 24. *Progress and Challenges to Realizing Roadside Detection of Acute Marijuana Consumption*. Brian H. Clowers, Peyton Nosbusch,* Herbert H. Hill, & Nicholas Lovrich. April 17, 2017. Azusa Pacific University (Invited Departmental Seminar).
 23. *Progress and Challenges to Realizing Roadside Detection of Acute Marijuana Consumption*. Brian H. Clowers, Peyton Nosbusch,* Herbert H. Hill, & Nicholas Lovrich. March 6, 2017. PITTCON, 2017, Chicago, IL (Oral Presentation).
 22. *Frequency Encoded Mobility Separations and Fragmentation Yields for Isomeric Tetrasacharides*. Brian H. Clowers, Kelsey A. Morrison,* Brad K. Bendiak. November 3, 2016. Lake Louise, ON (Oral Presentation).
 21. *Modification of Drift Gas Composition to Isolate Chemical Classes using Drift-Tube Ion Mobility Mass Spectrometry*. Brian H. Clowers, Zhihao Yu,* Pearl Kwtani-Barima,* October 28, 2016. Dusquense University (Invited Departmental Seminar).
 20. *Modification of Drift Gas Composition to Isolate Chemical Classes using Drift-Tube Ion Mobility Mass Spectrometry*. Brian H. Clowers, Zhihao Yu,* Pearl Kwtani-Barima,* September 19, 2016. Annual Conference of the Federation of Analytical Chemistry and Spectroscopy Societies, September 19, 2016, Minneapolis, MN.
 19. *High-Resolution Atmospheric Pressure Drift Tube Ion Mobility Spectrometry Coupled with Ultra-Accurate Mass Orbitrap Mass Spectrometry*. Zambrzycki, Stephen;* Li, Anyin;* Keelor, Joel ; Clowers, Brian; Fernandez, Facundo. September 19, 2016. Annual Conference of the Federation of Analytical Chemistry and Spectroscopy Societies, September 19, 2016, Minneapolis, MN. (Oral Presentation)

18. *Accurate mass and mobility speciation of metal complexes: Uranium, barium, cesium, and lanthanum.* Austen L. Davis,* Brian H. Clowers; 251st American Chemical Society National Meeting and Exposition, 2016, San Diego, CA. (Invited Oral Presentation)
17. *Untangling Gas-Phase Metal Chelation Using Ion Mobility: Strategies and Challenges.* Austen L. Davis,* Brian H. Clowers; 25th Annual ISIMS Conference, 2016, Boston, MA. (Oral Presentation)
16. *Advancing Mass Spectrometry Beyond m/z Measurements.* Brian H. Clowers. NSF Mass Spectrometry Interest Group, June 3, 2016. San Antonio, TX. (Oral Presentation)
15. *Ion Multiplexing: Tangible Enhancements for Ion Mobility-Mass Spectrometry.* Brian H. Clowers. University of Nebraska, Lincoln. Department of Chemistry Seminary Series. February 2016. (Invited Oral Presentation)
14. *Field Detection and Quantification of Inorganic Species from Surfaces.* Brian H. Clowers, Nathalie A. Wall, Austen Davis*, Riane Stene*, Christopher Veldhuizen*. July 21, 2015. DTRA Basic Science Technical Review. Springfield, VA.
13. *Modification of Drift Gas Composition to Isolate Chemical Classes using Drift-Tube Ion Mobility Mass Spectrometry.* Brian H. Clowers, Ph.D. October 15, 2015. Whitman College, Walla Walla, WA. Department of Chemistry, Seminar
12. *Modification of Drift Gas Composition to Isolate Chemical Classes using Drift-Tube Ion Mobility Mass Spectrometry.* Brian H. Clowers, Ph.D. October 27, 2015. Pacific University, Forest Grove, OR. Department of Chemistry, Seminar
11. *Gas-Phase Approaches to Metal Speciation,* Brian H. Clowers, Austen L. Davis*. August 4, 2015, Lawrence Livermore National Laboratory. Livermore, CA. DHS/DNDO Academic Collaboration Meeting
10. *Accounting for Gas-Phase Intermediates using Fourier Transform Ion Mobility Mass Spectrometry.* Brian H. Clowers, Austen Davis,* Zhihau Yu,* William F. Siems. PITTCON, March 8-12, 2015, New Orleans, LA. (Oral Presentation)

9. *Differential Photofragmentation Patterns for Mobility Selected Glycans.* Kelsey A. Morrison,* Enamuel H. Khan, Brian H. Clowers. 63rd ASMS Conference on Mass Spectrometry and Allied Topics, June 1, 2015, St. Louis, MO. (Oral Presentation)
8. *What Multiplexing Can Do for Your Experiment: Tangible Enhancements for Ion Mobility Spectrometry.* Brian H. Clowers, Austen Davis,* Kelsey Morrison* 42nd Annual Conference of the Federation of Analytical Chemistry and Spectroscopy Societies, October 1, 2015, Providence, RI. (Oral Presentation)
7. *Hybrid Multiplexing Schemes to Enhance Ion Throughput in Ion Mobility-Ion Trap Mass Spectrometry Systems.* Brian H. Clowers, Kelsey Morrison,* Austen L. Davis.* 24th International Conference on Ion Mobility Spectrometry, July 28, 2015, Córdoba, Spain. (Oral Presentation)
6. *Metabolite Detection of Naegleria species using Ion Mobility Mass Spectrometry.* X. Zhang,* Z. Yu,* Clowers, B. H., Hill, H. H., Miller, H., Puzon, G.J. 2014 American Water Works Association Annual Meeting. "Innovative Microbial Testing Methods," Wednesday, November 19, 2014. Atlanta, GA. (Invited Oral Presentation)
5. *Modification of Drift Gas Composition to Isolate Chemical Classes Using Drift-Tube Ion Mobility Mass Spectrometry.* Brian H. Clowers, Zhihao Yu, * Austen Davis.* Oregon State University Mass Spectrometry Symposium. September 24, 2014, Corvallis, OR. (Invited Oral Presentation)
4. *Ion Mobility Multiplexing and Hadamard Encoding Errors,* Brian H. Clowers, Zheng Xing¹, William F. Siems. Annual Southeastern Regional American Chemical Society Meeting, November 3, 2013, Atlanta, GA. (Invited Oral Presentation)
3. *Media Derived Protein Profiles of Microbial Samples,* Brian H. Clowers, David Wunschel, Nancy B. Valentine, Heather Engelmann, Karen Wahl. White House Interagency Microbial Forensics Advisory Board, Non-Genomic Forensic Signatures, July 12, 2012, Springfield, VA. (Invited Oral Presentation)
2. *Forensic Identification of Growth Conditions Using Residual Medium Peptides.* Brian H. Clowers, Helen Kreuzer, David S. Wunschel, Heather Engelmann, Nancy B. Valentine, Karen

L. Wahl. DTRA Chemical and Biological Science and Technology Conference, 2011, Las Vegas, NV. (Invited Oral Presentation)

1. *Analysis of Proteins and Metabolites of Unknown Samples to Complement Genetic Characterizations*. Karen Wahl, Nancy Valentine, Brian H. Clowers, David Wunschel, Christopher Ehrhardt, Heather Engelmann, Angela Melville, Kathryn Antolick, Jon Wahl, Janine Hutchison, Christina Sorensen. DHT Science and Technology Biological Forensics Review, 2011, Alexandria, VA. (Oral Presentation)

Conference Presentations

Since 2005 over 100 scientific presentations have been given in both oral and poster formats at a range of national and international conference venues. Recent, notable presentations include the following with the underlined name designating the presenting author:

24. Spatial Evaluation of Ion Populations in TW-SLIM. Cullen Greer*; Zackary R. Kinlein*; Brian H. Clowers (Poster Presentation)
23. *SLIM Pickins: An Interactive Circuit Layout Tool for Planar Traveling Wave Ion Guides*. Brian H. Clowers; Zackary R. Kinlein* (Poster Presentation)
22. *Addressing the General Elution Problem in TW-SLIM: Voltage and Velocity Ramps to Optimize Peak Profiles*. Zackary R Kinlein* ; Gordon A. Anderson; Brian H. Clowers (Poster Presentation)
21. *An All-in-One Power Supply for the Operation of Low-Pressure Drift Tube Ion Mobility-Mass Spectrometry Systems*. Thomas E Walker;* Robert L. Schrader; Nate Buzitis*; Gordon Anderson; Brian H. Clowers; David H. Russell; Jinyuan Liu (Poster Presentation)
20. *Mobility-resolved ultraviolet photodissociation of protein ions on an Orbitrap mass spectrometer using a reduced-pressure drift tube and aFT multiplexing*. James Sanders*; Nate Buzitis*; Jamie P Butalewicz*; Brian H. Clowers; Jennifer S Brodbelt (Poster Presentation)
19. Lowering the Barrier: Simplifying Traveling Wave Modulation in TW-SLIM using a Multifunctional Traveling Wave Generator (Poster Presentation) Zackary R Kinlein* ; Gordon A. Anderson; Brian H. Clowers. ASMS 2021, November 4, 2021. Philadelphia, PA
18. *Separation of Noncovalently-Labeled Disaccharide Isobars by Traveling Wave and Frequency-Modulated Drift Tube Ion Mobility-Mass Spectrometry*. Kristin R. McKenna,* Li Li,

- Kelsey A. Morrison,* Brian H. Clowers, Facundo M. Fernandez. Annual Meeting for the American Society for Mass Spectrometry Conference 2018, June 3-7 2018, San Diego, CA. (Poster Presentation)
17. *Development of a Multi-Source, Radially Confining Drift Cell: Alternative Configurations for SLIM.* Kelsey A. Morrison,* Brian H. Clowers. Annual Meeting for the American Society for Mass Spectrometry Conference 2018, June 3-7 2018, San Diego, CA. (Poster Presentation)
 16. *Generation of Digital Waveforms with High Resolution and Duty Cycle.* Nathan Hoffman,* Zachary Gotlib,* Brian H. Clowers, Peter T. A. Reilly. Annual Meeting for the American Society for Mass Spectrometry Conference 2017. June 4 -8 2017, Indianapolis, IN. (Poster Presentation)
 15. *Assessment of Dimeric Metal-Glycan Adducts via Isotopic Labeling and Ion Mobility-Mass Spectrometry.* Kelsey Morrison,* Brad K. Bendiak, Brian H. Clowers, Pearl Kwantwi-Barima*; Annual Meeting for the American Society for Mass Spectrometry Conference 2017. June 4 -8 2017, Indianapolis, IN. (Poster Presentation)
 14. *Comparative Metabolomic Profiling for Metastatic and Primary Melanoma Cell Lines.* Zhihao Yu,* Ming Huang, Brian H. Clowers. Annual Meeting for the American Society for Mass Spectrometry Conference 2017. June 4 -8 2017, Indianapolis, IN. (Poster Presentation)
 13. *Selective Ion-Neutral Clustering to Enhance Ion Mobility Separation Factors.* Pearl Kwantwi-Barima,* Brian H. Clowers, Annual Meeting for the American Society for Mass Spectrometry Conference 2017. June 4 -8 2017, Indianapolis, IN. (Poster Presentation)
 12. *Tuning Mobility Separation Factors via Selective Ion-Neutral Clustering.* Brian H. Clowers, Pearl Kwantwi-Barima*; Gas-Phase Ion Chemistry, Gordon Conference 2017. February 2017, Ventura, CA. (Poster Presentation)
 11. *Open-Source, Modular Approaches for Ion Mobility Spectrometry.* Brian H. Clowers, Gordon A. Anderson, Kelsey Morrison,* Peyton Nosbusch,* Austen L. Davis*; 25th Annual ISIMS Conference, 2016, Boston, MA. (Poster Presentation)

10. *Comparing Ion Multiplexing Techniques: Tangible Enhancement for Ion Mobility-Mass Spectrometry.* Brian H. Clowers, Austen L. Davis,* Kelsey Morrison*; 64th ASMS Conference on Mass Spectrometry and Allied Topics, 2016, San Antonio, TX. (Poster Presentation)
9. *Maintaining Speciation of Reactive Gas-Phase Complexes for the Metals Uranyl, Barium, Cesium and Lanthanum with Sulfoxides using AP-IMS-MS.* Austen L. Davis,* Brian H. Clowers; 64th ASMS Conference on Mass Spectrometry and Allied Topics, 2016, San Antonio, TX. (Poster Presentation)
8. *Frequency Encoding the Mobility of Isomeric Glycans: Separations Using Drift Tube Ion Mobility and Tandem Mass Spectrometry.* Kelsey A. Morrison; Brad K. Bendiak; Brian H. Clowers; 64th ASMS Conference on Mass Spectrometry and Allied Topics, June 6, 2016, San Antonio, TX. (Poster Presentation)
7. *Metabolite-based Detection of Pathogenic Naegleria in Water Distribution Systems using UPLC-MS.* Zhihao Yu, Haylea Miller; Geoffrey Puzon; Brian Clowers; 64th ASMS Conference on Mass Spectrometry and Allied Topics, June 5, 2016. San Antonio, TX (Poster Presentation)
6. *Mass and Mobility Distributions of Labile Metal Complexes of Uranium, Barium, Cesium and Lanthanum.* Austen Davis; Brian H. Clowers; 63rd ASMS Conference on Mass Spectrometry and Allied Topics, June 1, 2015, St. Louis, MO. (Poster Presentation)
5. *Maximizing the Multiplexing Advantage: Mobility-Specific Sources of Transform Error and Means of Correction.* Brian H. Clowers, Xing Zhang, William F. Siems. 62nd American Society for Mass Spectrometry. Baltimore, MD. June 2014. (Poster Presentation)
4. *Optimized metabolite extraction procedure for the detection of Naegleria fowleri in aqueous systems using Ion mobility and Mass Spectrometry.* Yu, Z., Zhang, X., Miller, H., Puzon, G. F., Clowers, B. H. Northwest Regional Meeting of the American Chemical Society, Monday, June 23, 2014. (Poster Presentation)
3. *Rapid analysis of uranium complexes using nanoDESI and Ion Mobility-Mass Spectrometry.* Davis, A. L., Hauck, B., Clowers, B. H. Northwest Regional Meeting of the American

Chemical Society, Monday, June 23, 2014. (Poster Presentation)

2. Multiplexing Strategies for Ion Mobility Spectrometry. Brian H. Clowers, Xing Zheng, William F. Siems. Annual Southeastern Regional American Chemical Society Meeting, November 3, 2013, Atlanta, GA. (Invited Oral Presentation)

1. *Forensic Characterization of Microbial Growth Conditions using Emergent Peptide Signatures.* Brian H. Clowers, Helen Kreuzer, David S. Wunschel, Heather Engelmann, Nancy B. Valentine, Karen L. Wahl. 5th National Biothreat Conference, 2012, Denver, CO. (Poster Presentation)

Grants and Research Support

Pending PI: Ewing, (Sub from PNNL) 10/1/2022 – 9/31/2026
 NNSA
 Non-contact vapor detection of high explosives (HE) and energetic materials
 Role: co-PI
 Amount: \$750,000 (Pending)

Pending PI: Davis, (Sub from Whitworth University) 8/1/2022 – 9/31/2025
 MJ Murdock Charitable Trust
 RUI: Development of Next-Generation Drift-Time Ion Mobility Spectrometry through the Application of Pulsed Ionization and Voltage Sweep Methodologies.
 Role: co-PI
 Amount: \$54,000 (Pending)

1R01GM138863-01 PI: Russell, (Sub from TAMU) 7/1/2020 – 6/30/2025
 NIH-EBIT
 Innovative Native Ion Mobility Approaches for Transformational Measurements in Structural Biology
 Role: co-PI
 Amount: \$617,125

R01 GM140129-01 PI: Clowers 9/1/2020 – 8/31/2024
 NIH/NIGMS
 Tractable Tandem Ion Mobility Technology using Structures for Lossless Ion Manipulations and Photodissociation
 Role: PI
 Amount: \$1,166,000

AWD000372G1 PI: Clark (Sub from GA Tech) 8/1/2019 – 7/31/2024
 NNSA : CONSORTIUM FOR ENABLING TECHNOLOGIES & INNOVATION (ETI)
 Role: co-PI
 Amount: \$ 1,246,049

NSF2003042 PI: Clowers 6/1/2020 – 5/31/2023
 National Science Foundation-CMI
 Collaborative Research: Tunable HDX and Ion-Molecule Interactions Using Doped-Gas Ion Mobility-Mass Spectrometry
 Role: PI
 Amount: \$255,458

US Army PI: Clowers 10/2018 – 10/2019

Construction of a Compact, Modular IMS System, manufactured by WSU

Role: PI

Amount: \$101K

US Army PI: Clowers 10/2017 – 10/2018

Purchase and Assemble Ion Mobility Spectrometer System (IMS), manufactured by WSU

Role: PI

Amount: \$86K

DURIP Army (Instrumentation Grant) PI: Clowers 08/2018 – 9/2019

Development of a Field Induced Droplet Ionization Ion Trap Mass Spectrometer

Role: PI

Amount: \$210K

Defense Threat Reduction Agency (DTRA) PI: Clowers 10/2017 – 9/2019

Option Years for Field Detection and Quantification of Inorganic Species from Surfaces

Role: PI

Amount: \$700K

Defense Threat Reduction Agency (DTRA) PI: Clowers 10/2017 – 9/2020

Option Years for Field Detection and Quantification of Inorganic Species from Surfaces

Role: PI

Amount: \$1050K

Washington State DSHS PI: Clowers 07/2016 – 07/2017

Roadside Detection of Marijuana: Accelerating the Pace of Development & Testing

Role: PI

Amount: \$250K

ADARP Dedicated Marijuana Analysis PI: Clowers 01/2016 – 07/2017

Alcohol and Drug Abuse Research Program

Development of Quantitative Marijuana Analysis Approaches for Small Volume Samples

Role: PI

Amount: \$31K

NSF Chemical Imaging Initiative PI: Clowers 9/2015 – 11/2018

National Science Foundation

Development of Radiative Ion-Ion Neutralization as a High Pressure Detection Mechanism for Ion Mobility Spectrometry

Role: PI

Amount: \$385K

ARO PI: Clowers 10/2015 – 11/2018

Army Research Office: Chemical Forensics

Real-Time Ultra Trace Detection of Organics from Environmental Matrices

Role: PI

Amount: \$450K

MUSC13003 PI: Clowers 3/2013 – 02/2016

Department of Homeland Security (DHS/DNDO)

Curriculum and Faculty Development in Technical Nuclear Forensics at Washington State University

Role: PI

Amount: \$200K

Technical Scientific Working Group PI: Wahl 5/2014 – 06/2015

Utility of Proteomics in Microbial Forensic Settings

Role: WSU Subcontract

Amount: \$870K (Clowers Subcontract: \$26K)

Note: This award was proposed by Clowers prior to joining WSU and serves as a joint appointment mechanism.

Office of Graduate Research, WSU PI: Clowers 5/2014 – 7/2015
 Optically Enhanced Mobility Separations: Selective Assessment of Stereochemistry
 Role: PI
 Amount: \$26K
Note: Project awarded as an outcome of the 2014 Grant Writers' Workshop with a subsequent NIH support awarded in 2021.

Defense Threat Reduction Agency (DTRA) PI: Clowers 10/2013 – 9/2016
 Field Detection and Quantification of Inorganic Species from Surfaces
 Role: co-PI
 Amount: \$1050K (Clowers Total: \$572K over three years)
Note: Basic research award is distributed between Clowers and Wall (WSU) with subcontracts to Oak Ridge and Savannah River National Laboratories.

Defense Threat Reduction Agency (DTRA) PI: Kreuzer 07/2011-07/2013
 Genomic and Phenotypic Characterization of *Yersinia pestis* During Long-term Serial Passaging
 Role: Co-Investigator
 Amount: \$1110K
Note: Final project closeout and results were completed after moving to WSU.

PNNL National Security Directorate LDRD PI: Clowers FY 2011-2012
 Statistically Significant Forensic Fingerprinting: Protein Analysis of Biological Agents
 Amount: \$180K
Note: Project awarded with Clowers as PNNL.

NSD PNNL Explosive Initiative LDRD PI: Clowers FY 2009-2010
 Enhanced Detection Mechanisms for Ion Mobility Spectrometry
 Amount: \$220K
Note: Project awarded with Clowers as PNNL.

PNNL Data Intensive Computing Initiative LDRD PI: Beagley FY 2008
 Intelligent Compression and Data Organization for Multidimensional Data Volumes
 Amount: \$56K
Note: Project awarded with Clowers as PNNL.

Service

Symposium Organization

Instrumentation: Innovative Separations Approaches Coupled to MS,
ASMS 2022, Minneapolis, MN

Instrumentation: Innovative Separations Approaches Coupled to MS,
ASMS 2021, Philadelphia, PA

ASMS Interest Group Organizer: Ion Mobility-Mass Spectrometry, 2016-2019

“Advances in Ion Mobility Spectrometry.” 2017 Scientific Exchange (SciX), September 19, 2017,
Reno, NV.

“Ion Mobility: Adding New Dimensions.” 2016 Scientific Exchange (SciX), September 19, 2016,
Minneapolis, MN.

“Fundamentals of Atmospheric Pressure Ionization Techniques.” 2013 American Society for Mass
Spectrometry Annual Meeting, Baltimore, MD.

Professional Service

Member of the Editorial Board, Journal of the American Society for Mass Spectrometry,
(2018-Present)

Complex Chemical Systems Dynamics Initiative Advisory Committee, PNNL LDRD
2017-Present

Treasurer Elect, 2015-2017 International Society for Ion Mobility Spectrometry

Treasurer, 2017-Present, International Society for Ion Mobility Spectrometry

ASMS Short Course Instructor, 2013-Present: Ion Mobility Mass Spectrometry

International Society for Ion Mobility Spectrometry Short Course Instructor, 2015-Present

ASMS Ion Mobility Interest Group Organizer, 2017-2019

ASMS Undergraduate Poster Competition Judge, 2013-Present

WSU Service Committees

- Member of the 2013 WSU Analytical Chemistry Faculty Search Committee. (2013-2014).
- Member of the WSU Tissue and Proteomics Imaging Laboratory Personnel Search Committee. (2014, 2019, 2022).
- Member of the Chemistry Graduate Student Admissions Committee. (Spring 2014-2018).
- Faculty Hiring Committee Chair for 2 faculty positions. (2019-2020)
- New Faculty Mentorship Committee Chair
- STEM Building Scoping Committee (2021-2022)
- Research and Arts Committee -- WSU Faculty Senate (2021-Present)
 - <https://facsen.wsu.edu/research-and-arts-committee/>

Peer Reviewing Activities

>120 Peer reviewed recommendations submitted since 2013

Journals:

- Analytical Chemistry
- Journal of the American Society for Mass Spectrometry
- Journal of Mass Spectrometry
- Journal of Chromatography A
- Physical Chemistry Chemical Physics
- International Journal for Ion Mobility Spectrometry
- Analyst
- Talanta
- Rapid Communications in Mass Spectrometry
- Review of Scientific Instruments

Agency Service:

- DOE SBIR
- PNNL/EMSL User Facility Review
- NSF
 - Career and MRI Reviewer
- NIH
 - R21, MRI, and P41 Review Panels

Mentoring

Graduate Students

Austin Davis	(09/2013 – 05/2018)	Degree: Ph.D.
Zihao (Joe) Yu	(11/2013 – 07/2018)	Degree: Ph.D.
Kelsey Morrison	(07/2014 – 05/2019)	Degree: Ph.D.
Pearl Kwantwi-Barima	(10/2015 – 05/2019)	Degree: Ph.D.
Peyton Nosbusch	(5/2016 – 05/2018)	Degree: M.S.
Cameron Naylor	(10/2016 – 06/2021)	Degree: Ph.D.
Andrew Pemberton	(10/2016 – 05/2019)	Degree: M.S.
Nate Buzitis	(10/2018 – 05/2023)	Anticipated Graduation 2023
Megan Nims	(9/2016 – Present)	Anticipated Graduation 2023
Haley Schramm	(9/2019 – Present)	Anticipated Graduation 2024
Zack Kinlein	(9/2019 – Present)	Anticipated Graduation 2024
Elvin Cabrera	(9/2019 – Present)	Anticipated Graduation 2024
Cullen Greer	(9/2020 – Present)	Anticipated Graduation 2025

Undergraduate Students

Angela Bowers (09/2022- Present)	
Andrew Deebach (11/2019 - 05/2022)	Graduated 2022, Chemistry
Virginia Ross (09/2017 - 12/2018)	Graduated 2018, Chemistry
Garret Radley (09/2013 – 05/2014)	Graduated 2014, Mechanical Engineering
Amikan Baleswarikan (09/2013 – 05/2016)	Graduation 2017, Electrical Engineering
Noor Alaa Aly (09/2014 – 05/2015)	Graduated 2015, Biology
Thomas Williams (05/2015 – 05/2015)	Graduated 2015, Mechanical Engineering
John Rodgers (01/2016 – 5/2016)	Graduated 2016, Chemistry

Teaching Experience

The table below outlines the teaching assignments for Dr. Clowers since 2013. During that time, 8 different classes have been developed and delivered across the graduate and undergraduate curriculum.

Course		Semester	Year	Enrollment	Credits	Critiques Instructor/Course
CHEM 520	Advanced Analytical Chemistry	Fall	2013	35	3	Team Instruction
CHEM 425	Instrumental Analysis	Spring	2014	12	3	3.5/3.5 of 5
CHME 220	Quantitative Analysis	Fall	2014	37	2	4/3.5 of 5
CHEM 106	General Chemistry: II	Spring	2015	200	4	3.2/3 of 5
CHEM 520	Advanced Analytical Chemistry	Fall	2015	28	3	Team Instruction
CHEM 592	Analytical Seminar*	Fall	2015	8	1	Team Instruction
CHEM 106	General Chemistry: II	Spring	2016	162	4	3.8/3.6 of 5
CHEM 517	Chromatography	Fall	2016	17	2	4.1/3.6 of 5
CHEM 220	Quantitative Analysis	Fall	2017	32	2	3.6/3.2 of 5
CHEM 528	Data Analysis for Chemistry	Spring	2018	14	2	4.4/4.1 of 5
CHEM 517	Chromatography	Fall	2018	15	2	4.3/4.0 of 5
CHEM 425	Instrumental Analysis	Spring	2019	24	2	3.4/3.2 of 5
CHEM 220	Quantitative Analysis	Fall	2019	32	2	4.1/3.8 of 5
CHEM 528	Data Analysis for Chemistry	Spring	2020	12	3	4.9/5.0 of 5
CHEM 517	Chromatography	Fall	2020	14	2	4.8/4.5 of 5
CHEM 529	Ion Mobility Spectrometry	Spring	2021	9	2	4.9/4.5 of 5
CHEM 528	Data Analysis for Chemistry	Fall	2021	7	3	4.8/4.8 of 5
CHEM 425	Instrumental Analysis	Spring	2022	14	2	4.7/4.7 of 5

* Dr. Clowers is also responsible for the coordination and instructor of record for the Analytical Chemistry Seminar. These classes are not listed for brevity.